GEOLOGY OF THE ENVIRONS OF TOKIO

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ENVIRONS OF TOKIO.

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PREFACE.

The geology of the environs of Tokio is a subject which has undoubtedly a very high interest for visitors and residents of Tokio or Yokohama, but above all for the Japanese students of geology to whom it offers some difficulties which no one, as far as I know, has tried to obviate. Unfortunately, I have not at hand Professor *Rein's* last publication about Japan, the only one I have before me being his paper on the Fuji-no-yama contained in the 25th volume of Petermann's 'geographische Mittheilungen'; but as the problems which form the main subject of this memoir are chiefly of a paleontological character, the author of the Japanese geography can scarcely have alluded to those difficulties. Although Dr. *E. Naumann's* paper concerning the Tokio plain,* contained in the same volume of the 'geographische Mittheilungen,' makes also no allusion to them, yet I have been obliged, in treating the same subjects, to advance opinions, as it will be seen, partly agreeing with, partly diverging from those of Dr. Naumann. A paper about the fossil *elephants* of Japan being under preparation by the same author, I preferred not to recur to the preliminary notices given by Dr. Naumann on this subject in the periodical of the 'Ostasiatische Geselltchaft.'

By far the greatest difficulty was the determintion of the fossil shells mentioned in chapters 4 to 7, a difficulty increased by the want of several of those books which ought to have been consulted. This circumstance is also the reason why I could *not* give a fuller account of all the organic remains, and confined myself to giving descriptions only of the Mollusca contained in the pliocene beds of Tokio and Yokohama. Of these, however, a few species were also excluded whose condition would not admit of an exact determination. From the molluscous fauna the conclusions concerning the horizon and nature of the strata were drawn. As a similar way has been followed by other authors in a great many instances, I think I have committed no error in doing the same in a case which was not only of great importance, but also did not promise to yield other means of solving the problem.

The books mostly consulted were *Lischke's* japanische Meeres-conchylien, contained in three volumes, published by Fischer, Cassel, in the years 1869 and 1874-1875. This work, richly illustrated and critically written, mentions (and mostly describes) 429 species of Japanese mollusca, and so made up for the want of other books, e. g. *Dunker's* and *Schrenck's* works on Japanese Mollusca. The local fauna besides was partly given in *Gould's* Otia conchologica, or, descriptions of shells and mollusca, from 1839 to 1862, Boston 1862, to which the Plates of the Mollusca from Wilke's exploring expedition, by the same author, were a highly welcome addendum. Pacific shells are besides described by *Carpenter* in the Proceedings of the California Academy of natural sciences, whilst *Gould's* publications, except those already mentioned, are chiefly contained in the Boston Proceedings of the society of natural history, quoted in some instances in this memoir.

As the nature of the fauna described will show, the comparison with Atlantic shells was of a much greater importance than, perhaps, could have been expected. This was done chiefly with the aid of *Forbes* and *Hanley's* british Mollusca, 4 volumes, London, 1853, of *Jeffreys* british Conchology, 4 volumes London, 1867 (year of last publication), but also of *Gould-Binney's* report on the Invertebrates of Massachusetts, 2d ed., Mollusca, Boston 1870, *Stimpson's* revision pp. Boston 1857, *Tryon's* American marine Conchology, Philadelphia 1873, *Weinkauff's* Conchylien des Mittelmeeres, 2 volumes, 1867 and 1868. But it was quite as important to compare the shells in question with other fossil shells; and for this purpose the 'Crag-Mollusca,' described (and figured) by *S. Wood* in the reports of the Paleontological Society of London (in two sections, one contained in 3 different numbers, with two supplements, the first of which has also 2 parts, the whole published within the years 1847-1879) were most essential. The subapennine fauna could not be consulted in the original publications; but this was the case again with a great part of the German papers on the fossil beds of Mayence, Vienna, Cassel, Soellingen, on the Mecklenburg tertiary layers, &c., as well as with Nyst's accounts of Belgian fossils. *Goldfuss'* Petrefacta Germaniæ—of course—were sometimes of great use.—As the Brachiopoda were added to the true mollusca, the papers of *Davidson*, above all his paper on Japanese recent Brachiopoda, from the 'proceedings of the Zoological Society of London,' April 18th, 1871, page 300-312, and pl. 30 and 31, were consulted.

With the aid of all these books—and many others used on different occasions, all of which need not be mentioned—I feel I have only made a preliminary step in an investigation which, though offering very great difficulties, is of such importance that it seemed to me to require immediate treatment. A further delay would, above all, have been disadvantageous to the students of the Daigaku; I need, therefore, make no apology for this Memoir.

I cannot omit to call the attention of the reader to the clever way in which the Japanese artist, Mr. H. Hirauchi, has done his work in designing the illustrations, and chiefly a certain number of the pliocene shells. Though—among the more frequent, or otherwise important species—only such specimens were selected, as were well preserved, yet the task set to him was so entirely new, that the difficulties he was to surmount are not to be underrated. Much of whatever is excellent in the appearance of the book is due to the successful execution of his work. As to the printing &c, it may be called in this case as well as in the preceding memoirs 'surprisingly elegant and correct.' I seize this opportunity of expressing my best thanks for all the aid given me in this direction by the Presidents of the Daigaku.

I offer likewise my thanks to the director of the Zoological department for the kindness with which he opened to me all those parts of the Daigaku collections under his care.

Finally I add my thanks to my assistants, past and present, for the aid given me in making these researches, Messrs Sekino, Kato, Kochibe and Nishi, to whom I must add the names of two of the students of the Daigaku, Mr. Yamashita and Mr. Fujitani.

Tokio, December 1880.

The Author.

CHAPTER I.

INTRODUCTION.

The environs of Tokio, the capital of the Japanese Empire and, at the same time, the place in which most of the collections, colleges and schools of Japan are united and in which therefore also the university or Daigaku has been founded, exhibit, geologically, a much smaller number of rocks and formations than we might wish for. This is the more to be regretted as these environs are part of a vast plain everywhere constructed on the same plan and showing essentially the same formations, so that, in order to reach rocks and strata of a different kind, the student of geology is always obliged to make long and rather tiresome trips in a country which, it must be admitted, has but imperfect roads and means of conveyance, and offers but very few comforts to travellers. Moreover, the mountains encircling the large plain of Tokio—the largest in fact of the Japanese Empire, and for that reason most likely selected for the site of the capital—present little variety. In almost every direction we find rocks of a similar character and origin on leaving behind us the formations of the plain—those diluvial plateau-like heights intersected by rivers and rivulets, and more or less broad alluvial valleys, which we are to describe in the first chapters of this paper. Those rocks of the adjacent hills and mountains, forming as it were a vast quadrant, to which the small isolated district of Uraga is to be added, are indeed mostly crystalline sedimentary or schistose rocks, micaschists, calcareous micaschists, chlorite-schists, intermixed with quartzites, crystalline limestones, and cipollines, in a few instances passing over to gneissic rocks, in other instances (N. and N.W. of Tokio) to quartzitic conglomerates or to limestones containing few kinds of recognizable organic remains—crinoïds, belonging to the tesselate ones, orthocerata, and fusulinæ—, all proving that these rocks are at least of a palaeozoïc age. In some parts, as for instance in the Tsukuba-mountains, which, from the northern and northeastern side, project somewhat farther into the plain than the rest of the neighboring heights, or in some parts of the Chichibu district and farther to the west, or in the mountains which northward from Mito verge nearly to the sea-side, we find granites, diorites and other plutonic rocks of a rather ancient origin; whilst in a few localities, especially in the southern part, along the coast, recent volcanic rocks with their tufas are widely spread. These tufas indeed pass gradually into the formations of the plain and especially into the neogene tertiary rocks which may be said to be the most attractive formation of it. These volcanic rocks have their highest level on the top of the Fuji-no-yama, that well known normal volcanic cone of gigantic dimensions which is situated to the W.S.W. of Tokio at a distance of about 65 miles, and whose crater, now nearly filled with barren ashes and lapilli, forms a hollow cone not more than about five hundred feet below the high and sharp ridge encircling it. The volcanic action has totally ceased on the high top of the giant-cone,—the last eruption, nearly two centuries ago, having affected only a side-cone, the Hoyei-san, about half way up from the western base—, and we see but slight traces of it in the environs of Hakone, at a direct distance of about 12 miles from the top of the Fuji-mountain, so that it seems to have retreated to the sea. Indeed it seems to have its main centre now in the volcano of the island of Oshima, nearly SSW from Tokio. Not only the last vigorous eruption—about a century ago,—but also smaller ones seen and described and partly pictured by European geologists, and, as it becomes obvious from a great many dates of the seismoscopical offices, a part at least of the earthquakes so frequently occurring at Yokohama and Tokio, point to this fact; whilst on the other hand, the volcanic phaenomenon of the districts in the north of Tokio, especially on the Asama-yama, whose last great eruption is recorded to have taken place 6 years after that of Oshima, is now apparently less vigorous and not much above that degree of intensity which is exhibited by the hot springs and the sulfurous exhalations near Hakone. As for the sedimentary rocks overlying the older crystalline sediments, they are, as far as they are known in this vicinity, all very young, being partly tertiary, partly quaternary. The tertiary rocks, though very thick and developed in different shape, as shale, conglomerate and sandstone, are not, or not much, older than the tertiary rocks which we shall find in the plain, and form indeed one and the same system, rich throughout in such species of mollusca, as still survive in the Japanese seas. These rocks form sometimes beds and basins encircled by the micaceous schistose rocks, partly large, as for instance that which extends between Nigawa and Minano in the district of Chichibu, partly smaller, as one which has been discovered in the environs of Sukegawa, in the north of Mito and near the eastern coast. Other parts of those tertiary strata are spread along the boundaries between the crystalline system and the quaternary soil of the plain, as for instance between Mito and the mountains in the north of that town, or in the district of Komagori, or westward from Yokohama. The rocks constituting this part of the country, which though not perfectly contiguous, may be called a belt encircling the plain, are mostly sandstones, sometimes rather impure and frequently passing into conglomerates and tufaceous rocks. In the latter case they contain sometimes fragments of pumice, in the former, they are rich in small and worn fragments of crystalline rocks, representing all the different kinds occurring in the adjacent mountains. The species of fossils found in the sandstones—unluckily very often mere casts or moulds—are of course of great importance. We shall, therefore, be obliged to recur to them in the following pages. It may suffice here to mention among them Nassa livescens Phil., Columbella scripta L., Mya. arenaria L., Cyclina Sinensis Gmel., Mactra veneriformis Desh., Dosinia Japonica Reeve, whose identity, however, with the true

Dosinia exoleta L. will be proved in the following pages, and Cardium muticum Reeve, all of which have been found frequently and in more than one locality, and serve to illustrate sufficiently, what has been said about the character of these strata.

The quaternary formation looses the character which it exhibits in the plain, whenever we ascend a few hundred feet above the level which it has near the sea side, in the environs of the bay of Tokio. The valleys of the rivers are terraced also there, but the differences between the true diluvial and the true alluvial formation disappear, and instead of them, a formation is developed containing large pebbles, shingle and sand mixed with loose, impure soil, such as we frequently find along the slopes of steep hills or mountains. As this formation passes insensibly into very recent deposits, there can scarcely be any doubt about its being partly of recent origin, and corresponding to the undoubtedly alluvial deposits of the lower part of the river valleys. But this cannot be said of the totality of these loose quaternary conglomerates, as there is evidence of organic remains in them which belong to extinct mammals. Though the species could not be always ascertainted there can be no doubt about the genus Elephas (v. Chapter 3.) occurring not unfrequently in the beds described above, which, as scarcely needs be mentioned, cover unconformably all the other formations, palaeozoic or tertiary, with a coat which sometimes has many metres of thickness, whilst, in other instances, it is partly or entirely eroded and taken off by the waters, or even may have been prevented by them from being deposited at all. As good examples of such deposits we may mention again the districts of Chichibu and Komagori, the latter exhibiting moreover the passage between the above-mentioned conglomerates and the more clayish soils forming the upper part of the deposits of the plain, a passage gradually appearing just beyond Hanno. Having thus encircled the large plain of Tokio and characterized the mountains in its circumference, upon which, therefore, its deposits are somewhat dependent, we may proceed to describe the plain itself and the parts into which it is to be divided.

Of course the difference is most obvious between the river-valleys themselves and the parts of the plain in which the valleys are cut. The smaller valleys and side-valleys, and on the other hand all the innumerable smaller or larger portions of the higher plain left between the rivers and rivulets, exhibit a similar if not identical character. This uniformity in character of both of these formations relieves us from enumerating all those rivers, which in a very great number descend from the water-ridges towards the plain and reach the sea, partly in the bay of Tokio, partly in the adjacent parts of the ocean. The largest of all those rivers, the Tonegawa, is renowned for the partitions which take place about 40 miles from the mouth. Some of its arms run into the open sea, the largest of them forming a sort of lagoon-district barred from ocean by sand-banks, similar also in some respect to the Nehrung which severs the mouths of the Baltic rivers called Haffs, from the open sea. Besides the lagoons themselves a large fresh-water lake, the Kasumiga-Ura, is to be mentioned, not more than about 8 feet above the level of the sea and, as it were, a repetition of the lagoons in a somewhat higher level. The other arms, among which the Yedogawa—a little eastward from Tokio, and from the arm which almost touches the capital, the Nakagawa—is most important and is used not only by common boats but also by steamboats. In their lower part, these arms have branches communicating with the stream which runs through Tokio, the Sumidagawa; and also in its upper course this river sends tributary arms to the system of the Tonegawa. The same river, called Arakawa in the upper part of its course and running through the district of Chichibu, divides, in its lower part, Tokio itself (Asakusa) from the suburb of Mukojima. Together with the western arms of the Tonegawa, it forms a sort of delta which we may call the delta of Tokio. Of course, we are to confine this name to the environs of Tokio, and cannot call delta the whole space between the western and eastern arms of the Tonegawa, nor, as is obvious from what is said above, any part of the region of the mouths of the eastern arms. It may be added, that the other river-mouths in the Tokio-bay, among which that of Kawa-saki between Tokio and Yokohama is the most important, have the same character as the Tokio-delta, whilst the river-mouths as well of the eastern coast bordering the open ocean, as of the southern coast to the west of Yokohama are more or less similar to that of the eastern arms of Tonegawa.

It may be added that, as a rule, the soil of the latter is sandy, sometimes intermixed with other minerals, among which magnetic iron sand may be mentioned, in the north of the north-eastern Tonegawa arms, whilst in the bay it is mostly clayish. In the first case, we may also notice that the bluffs and cliffs, mostly formed of sandstone or tufaceous rocks, are much oftener projecting far into the sea, whilst in the bay, we find such projecting rocks only in the southern part. The interior or northern part of the bay generally exhibits a broad margin of low, mostly clayish lands, the bluff line being situated at some distance from the sea.

As stated above, the parts of the plain which are not cut deep by rivers or by the waves of the sea are considerably higher, even in the closest vicinity of the sea. We find the level of this higher plain, or plateau, about 28 metres above the sea at Tokio, and nearly equally high, nay even a little above 30 metres, at Yokohama and its environs. The surface of the higher plain given by strata which, near the surface, are always nearly horizontal, is more regular than the alluvial deposits themselves which not only follow the slope of the valleys but are also disposed in a somewhat different way in the same cross-section of the valley. In such a cross-section the riverline itself may be grooved rather deep into the other alluvial layers, and terraces may often be seen which always divide younger and older alluvial deposits, the youngest alluvial strata being always found in furrows cut deep into the older ones, exactly in the same way, as the totality of the alluvial formations is cut into the diluvial, or even into any other older formation. Thus it comes, that all the diluvial parts of the plain appear as isles or peninsulas, divided from one another by all those river-valleys and side-valleys of tributary rivers and rivulets, down to the most minute undulations of the ground or ravines and torrent-beds.

It is to be mentioned, that this division of the surface of the plain is of the highest importance for agriculture, the rice-fields being in most instances confined to the lower or alluvial tracts, and generally filling them, whilst on the higher level we find the barley, wheat, millet, Indian corn, the many kinds of beans, the nasu, satsuma-imo and sato-imo, and at the same time the plantations of tea, of the mulberry-tree, and also most of the small forests; whilst the villages and towns with their bamboos and garden-trees and shrubs are indifferently spread over both sorts of localities. It will appear from the following pages that the geological constitution of all these originally contiguous and only posthumously intersected higher parts of the plain is also geologically identical or nearly identical, the surface being almost always formed of iron-ochre coloured sandy clays or loams, and that they are always widely different from the deposits of the river-valleys imbedded between them.

The level of these higher parts of the plain does not, of course, show great differences. In the vicinity of the capital 30 metres are—as above stated—the average height wherever the formations are completely developed, the more elevated heights which occur not exceeding about 45 metres. But even at some distance, e. g. near Tsukuba, or Odawara, scarcely any difference is to be observed. In the neighbourhood of the mountains, however, we get levels of 70 to 150 metres above the sea, and of course the river-beds themselves exhibit a corresponding increase of level. Generally speaking, we have a very uniform plain or, as we may call it and have called it above, in spite of its rather low level, a *plateau* widely spread around Tokio, which must have been deposited by the sea and under its surface, and therefore must have risen above the level of the sea since the diluvial epoch in which it was formed.

The act of elevation itself which is believed to continue to the present day, and which has been the object of a paper 'Ueber die ebene von Yedo'—lately published in the' geographische Mittheilungen 'of Petermann—by Dr. E. Naumann, will be discussed in the concluding chapter. I therefore proceed to point out some remarkable features of the country as it now appears.

The very first objects which strike the new arriver at Yokohama and at Tokio are the steep bluffs which appear, as has been said, at different distances from the sea, but form an almost continual, though very irregular line. The identity of these bluffs—of the Bluff on the southern side of Yokohama, of those of Kanagawa, Shinagawa, of some parts of Tokio, of Oji—is indeed obvious, and we may say without any doubt that the deep cuttings of river-valleys and ravines into the plateau-formations of the inland are also precisely of the same nature and origin. We find, therefore, comparatively the steepest and highest slopes next to the sea-side; for the water-courses, which necessarily run down according to the well known parabolic law and which, as we have seen, are cut through a nearly horizontal plateau, must be most strongly opposed to the plateau-surface next to their mouths, and the very highest precipices must, at all events, be found next to the sea side. Consequently we see the best exposures and geological openings, and above all those which give the most perfect sections, in the vicinity of Tokio and Yokohama and other places near the shore. It is not, therefore, at of all astonishing, that chiefly at Tokio, Kanagawa, Yokohama we find those openings and steep slopes which exhibit the lower parts of the plateau-formations.

The higher of them—if we deduct the less important alluvial deposits on the very top of the diluvial layers of the plateau—are undoubtedly *diluvial*, and may be taken as a sort of base for further investigation. Now there is everywhere a series of more or less thick strata, which often uniformly, or comformably, succeed the uppermost deposits and, as scarcely needs be mentioned, are always horizontal. These strata, partly clayish, partly sandy, sometimes tufaceous and very often intermixed with thick layers of round pebbles, sometimes fill up the total height from the level of the sea or the deepest point to be observed in the sections, whilst in many other cases they are only some metres thick. But in both cases a line of uncomformability is below them, and indeed this line is always more or less clearly to be seen whenever we have the second case in which the diluvial formations described above do not reach the lowest part of the section. The strata below that line of uncomformability are sometimes nearly horizontal; but in many other cases they are more or less strongly inclined. We may therefore assume that they are different in age and formation from the upper ones. Indeed they are to be determined without any prejudice and without excluding them a priori from any formation belonging to or older than the diluvial era. It is not altogether excluded, that they might belong to the older part of the, 'Diluvium' or quaternary epoch; they might be, on the other hand, of a very old origin, and it is not without a deeper study of all their peculiarities of structure , and above all of their organic remains, that we are allowed to draw a conclusion about their nature. Now it has been already mentioned that a great part of their organic remains, especially of the fossil mollusca, belongs to recent species, and this fact shows that, if not diluvial, they are of a very recent—or neogene—tertiary origin. Whether the one or the other case is before us, will appear, as has been already hinted, in the following pages. It may be noticed before-hand that the conclusion drawn from the mollusca found at Oji, Shinagawa, Yokohama &c, viz. that the deposits must be tertiary and not quaternary ones, is confirmed by the strictness with which the line of uncomformability appears, and by the strongly marked differences in the angle of dipping between the two series of strata—either above or below that line—, which are often to be observed. Instances of both facts will be given in the detailed descriptions of the sections of Shinagawa, Kanagawa, Yokohama, Takigashira, Surugadai and Oji. Thus, both the architecture of the formations and the paleontological character tend to prove that the shell-layers below the line of uncomformability, which very often form the very top of the deeper formation, are indeed a very young and high part of a system which includes all the abovementioned tertiary beds and basins of the slopes and within certain excavations of the old sedimentary rocks of the mountains encircling the vast plain which is the object of this memoir.

This system is indeed a unit and does not exhibit uncomformabilities, nor even very striking lines of partition. We are well enabled to point out younger and older strata in the thick succession of layers which it includes, but only by the very fact that they overlie one another. The connexion of the shell-beds of Tokio and its environs, with those of the environs of Sukegawa and other places in the north of Mito, can also be very nicely traced along the road from Tokio to Mito and farther northward.

It deserves to be noticed that in no part of the plain of Tokio is any trace of glacial deposits to be seen nor any trace of gracial action on any of the formations. Of course we could not expect, from what we know of other countries, to find such traces in any but the diluvial formation, but even in this formation we look for them in vain. This fact is fully admitted by the author of the above-quuted paper, Dr. E. Naumann; he adds, however, that there are certain signs of a lower temperature having existed during that formation. I do not think those signs really exist. The Elephas, or Mammoth, which is mentioned in Dr. Naumann's paper, is not Elephas primigenius Blumenbach (see chapter 3rd), and so falls rather short of proving this abatement of temperature, and the presence of a few mollusca in the *tertiary* beds which are now confined to the seas round the isle of Yesso—or even farther to the north—gives of course still less evidence of a lower temparature during the *diluvial* epoch. Indeed this fact must be explained in a thoroughly different way since other fossils of the tertiary beds would rather seem to indicate a higher temperature of the tertiary age. I have been always of opinion that it is a little rash to draw conclusions from the presence of this or that species of fossil plant or animal on the climate of past ages. In most instances we do not know the animals or plants themselves and are to form our conclusions on the assumption of more or less strict affinity between them and surviving species, and the case of Elephas primigenius and Rhinoceras tichorhinus ought to have shown sufficiently how erroneous such conclusions may turn out. But even when we know the plants and animals, we are not allowed to derive any definite dates from their actual geograhical distribution. Professor Fraas, of Stuttgart, one of the best German Geologists and well versed in researches of deposits of many formations and climes, found on studying the prehistoric fauna of southern Germany—about 50° of northern latitude—a complex of animals which reminded him of the collections made for show, or in a zoological garden, lions, hyaenas and other animals of southern latitudes cast together with reindeer, and other animals of frigid climates, and with horses, stags, bears and many other animals existing nowadays in the same latitudes. All these species are asserted to have been strictly contemporaneous. Now it is obvious that the reindeer has retreated just as far to the North as the lion has retreated to the South, and if we should infer from the former that the climate has been colder than it now is, we should be obliged by the presence of the lion on the other hand to assume that it must have been warmer than it actually is. The whole set of facts referring to this theme is fully explained if we keep in mind that any species of plants or animals may have been restricted to a smaller area by the struggle of life to which it was subjected. Species better adapted to a cold climate persisted there but were restricted from the southern part of their area, whilst the reverse took place with those species which were better adapted to a warm climate. Without admitting this fact, we should be indeed at a perfect loss how to explain the majority of facts connected with the study of tertiary floras and faunas, and it obliges us much more than it is the custom among paleontologists, to restrict our conclusions and statements on the temperature of the different continents and oceans. Indeed the area over which the majority of species are spread is far larger and includes a far greater variety of climates than is generally admitted; and the range of latitude, which a given species may have, or may have had in the course of geological ages, is very often undoubtedly a much larger one.

Making an application of these views to the matter in question, we may say that the climate of the latest tertiary times may have been a little warmer—or a very little colder—than it is now, but that it may just as well have been exactly the same.

Still less may we form any conclusions on the temperature of Japan during the diluvial era, whose fauna we know but imperfectly, and whose flora to a necessity was the same as that of both the youngest tertiary age and the present time, and which does not exhibit those glacial phaenomena which give such a high interest to the study of the quaternary formations of England, Scandinavia, Germany and Switzerland. During this period, which so strongly divides the genial climate of the miocene era of Europe from the less warm but also fertile present era of the same part of the world, we find in southern latitudes, such as that of Tokio and its environs, nothing but a deposit of detritus indicating a smaller extension of the land than we have now, and no proofs of a climate differing from that of the present age, the only reasons for admitting a lowering of the temperature being derived from the observations made in higher latitudes.

In fact the absence of the glacial phænomenon is exactly what might have naturally been expected. The latitude of Tokio, similar to that of Gibraltar or Damascus, together with the absence of Alpine mountains, would be scarcely in accordance with the presence of inland-ice, such as has been proved to have existed in the above-named European districts. The absence of any traces of it relieves us from pointing out such heavy changes in the configuration of the land and its surface as could be reconciled with the glacial phænomenon. It is true, indeed, that the above mentioned German geologist, Fraas, is of opinion that exactly in the same latitudes, and even a little father to the south, viz. in the southern prolongation of the Jordan-valley beyond the Dead Sea and on the

Sinaïtic peninsula, glaciers have existed; but his opinion, which as far as we know has never been shared by any other geologist, is neither proved to a certainty, nor even recurred to by the author himself, and the only argument given by him, the configuration of the surface of the hills and valleys, may be equally well explained in a different way.

Whether the diluvial era, which at all events, in the main, represents a state of things intermediate between the tertiary and recent time, but which locally and temporally may be opposed to either, brought indeed a colder temperature than that of the present day to Japan and the adjacent parts of Asia, can not be explained by the data given us by Japanese geology. Thus, the answer to this question depends upon the answer which geology will give to the important question, to what degree did the influence of the increase of northern ice and cold, which undoubtedly took place at least during a part of the diluvial era and caused its temperature to be somewhat like that of the southern hemisphere of the present age, extend towards the aequator. However probable it may seem that such an influence has been felt in a similar way as the influence of the heat of the Sahara-desert and of the winds arising from it is to be felt in a great part of Europe, and as the influence of the moist and warm monsoon of eastern India is nowadays felt in Japan:—we are not able to assert that it took place, and much less are we able to speak about any degree of it. At any rate there seems to have taken place a slight and gradual alteration of our climates since the tertiary period, and if the degree of abatement was, in the average, not very high—as there are many reasons to believe—, we cannot deny a strong change of our climates in another way, namely, that the seasons became more distinct and opposite, and that with an abatement of the temperature of winter there is most likely to notice an increase of warmth of summer. This change seems to have gradually begun towards the end of the tertiary period.

Indeed the assumptions and views here stated are quite sufficient to explain, in connexion with the theory of natural selection, all the facts connected with the changes of our faunas and floras since the miocene time.

We find indeed, that Japan has not only at that period but down to a much more recent date had its share of the palæarctic faunas and floras, which to a certainty have been in connection with the living fauna. The continental archipelago, whose centre and most important part is the main island of Nippon, has indeed preserved some features which have disappeared elsewhere; and we find here a corroboration of that law, which so strongly confirms Darwin's theory, that isolated parts of faunas and floras escape the severest consequences of the struggle of life and of natural selection, and may preserve certain characters even long after they have disappeared elsewhere. In some cases, such remnants of ancient floras and faunas are likewise preserved in other countries, though very often on the continents they are pushed much farther to the south.

As examples of such remnants of old floras and faunas may be quoted Gingko biloba L., a plant known from the miocene and pliocene European floras under the name of Gingko or Salisburia adiantoides Heer, and the Japanese giant-salamander belonging to the genus Sieboldia whose nearest allies are found in miocene deposits of Europe.

Of course it would lead me too far, if I would go through the recent fauna or flora of Japan, in order to elucidate these theses more in detail. It may suffice to have pointed out here their general and most striking features, and to apply the laws thus derived to that portion of the faunas, which is imbedded in the strata which constitute the formations of the plain of Tokio, and which therefore will be the object of the following chapters.

CHAPTER II.

THE ALLUVIAL DEPOSITS.

It might seem perhaps that the *alluvial* deposits are comparatively of little consequence and, therefore, less interesting than the rest of the stratified formations. Inconsistant as this mode of viewing things is with true science, it turns out to be perfectly erroneous whenever we enter more deeply into the subject. Not only is the agricultural importance of the alluvial deposits of the river-valleys and of the deep plains along the sea-side very great, but also a minute investigation of all these deposits is of utmost consequence theoretically, for any studies of prehistoric remains.

I need not dwell upon this point, as another Memoir of the Daigaku, 'The Shell Mounds of Omori' (by Edward S. Morse (Vol. I, part 1 of the memoirs) shows sufficiently the great importance which these researches have especially for the district whose geology we are treating here. This importance calls for the greatest precaution with reference to those shell-mounds, the more so as there are a great many difficulties to be overcome. It would be preposterous to call every larger accumulation of shells a shell-mound; many of them are produced by nature and not by men; other are accumulated by men in more recent (historic) times. But a great many of these deposits are indeed the products of human action in a remoter period. The characters belonging to such artificial shell mounds are, of course, easily determined—those mounds are never overlaid by any but recent alluvial deposits—they are accumulated and not arranged in layers or strata—and moreover they are, if not always, yet almost always intermixed with products of human art and industry, with waste of cookery, bones of animals &c. The nature of the products of art as well as the character of the human bones occasionally found within the mounds gives always the best intimations of the age to which they belong.

All these objects having been carefully taken into consideration, we may indeed safely accept the result of the above quoted author concerning the prehistoric character of the mound of Omori—and also that of Onomura, province of Higo, mentioned by Morse in the chapter about the platycnemic tibiæ—, though we may omit a further discussion about the exact era of its construction.

Of course in a country where people are eating daily a very large quantity of shell-fish, we have shell-heaps or deposits of any date up to the present day, and as those heaps are almost always accumulated next to the human dwellings, they may be very easily mistaken for shell-mounds by any one who is not well versed in anthropological researches. Wherever such accumulations are found next to the doors of existing houses, or within a village, or next to the landing-places of fishermen, there is indeed scarcely any danger of a mistake being made; but whenever they are found in a comparatively desert place and at a larger distance from the sea, we are indeed forced to reserve our verdict until an accurate investigation of the mound has been made, and a thorough knowledge of all remnants of pottery and other branches of industry contained in it has been obtained. There may be cases where even native tertiary shell-layers are not easily distinguished from artificial shell-heaps. This difficulty is greatest whenever we are to deal with such parts of those shell-layers as have been washed away by the recent sea and therefore, though of tertiary origin, are no longer contained in tertiary strata, but in alluvial strata, into which they have been newly and posthumously imbedded. This, indeed, is the case with a great many accumulations of shells along the base of the ancient bluff-line at Uyeno, Oji, and other parts of Tokio and its suburbs, where we find shells of the same description and of the same species as in the more ancient and deep shell layers of Oji, Surugadai &c., under the soil of the rice-fields, spread along the base of the diluvial hills. This origin of the shell-deposits found in those places is indeed rendered obvious by the occurrence of undoubtedly tertiary layers in their close vicinity and by the absence of any other cause which could afford the shells. But in such localities, as for instance on the southern side of the Yokohama-bluffs, where the waves of the sea come actually into close contact with the base of the bluff, or at least very near it, it is sometimes impossible to draw a certain distinct limit between recent shells and tertiary shells deposited in a secondary way by the torrents, breakers and waves of the present age. We may add, however, that in such cases this distinction is generally of slight importance and serves only to make still more evident the necessity of utmost accuracy in all those researches which concern alluvial shell-deposits.

If we try to classify the alluvial formation, we may proceed in two ways, either arranging them simply according to their chemical and mineralogical qualities, or according to their geological age or comparative antiquity. In the first case, we are to separate the clayish and sometimes somewhat calcareous deposits of comparatively calm and stagnant water, together with the peat-deposits made in perfectly stagnant water, from the sand deposits of rivers running with some rapidity, or of the shore of a rougher sea. We may say indeed, that the minerals contained in the rocks from whose destruction the alluvial deposits have been formed, are not without influence on the nature of these deposits (the magnetic-iron sands of the eastern coast being a striking example of this influence), yet the minerals forming the greater part of those sediments—quartz and common clay together with some lime—occur in almost every kind of rocks and are scarcely wanting in any locality. We see, therefore, that modifications produced by the action of water are of the greatest importance for the constitution of any sediment, and serve above all to sever the different sorts of bulk and weight, causing in one instance coarse sands or even conglomerates, in another fine-grained, or impure sands, in a third clayish parts to be gathered and deposited together. Thus, we see along the coast surrounding the plain of Tokio, sands and clayish soils alternating and often occurring close to one another, according to the degree of exposure or protection of the part of the strand to which they belong. Thus, sandy deposits prevail along the open coast, especially along the eastern coast, but there are also parts of the shore of the Tokio-Bay which are sandy in consequence of their being exposed to the direct influence of the waves of the sea. One of these places is to be seen along the road from Yokohama to Odawara, and is one of the best examples of this kind. Another kind of soil, which is not very frequently met with near Tokio, is also found near Yokohama—the peat and peaty soil. Near Takigashira-mura we have the following section in those parts which cover the strata to be mentioned in one of the following chapters, and which at the same time are situated nearer to the sea:

1 Meter	of sandy clay, blackish and intermixed with peat.
0.6—	peaty substance.
0.5—	impure sand, coloured dark by peaty admixtures.
0.2—0.3	loose conglomerate (rounded pebbles with dark and somewhat peat-coloured soil between).
0.4—	impure sand mixed with pebbles.

Under this layer we have that line of unconformability, which separates the quaternary beds from the tertiary deposits, and which we shall discuss hereafter. The layer next to that line is a shell-layer of a similar importance and of the same character, mostly also containing the very same species, as that of Oji. As to it, we refer to the 6th chapter, and add here only, that clayish soil, always a little sandy, is widely dispersed through the bay near Takigashira, in which we find a profusion of such species of shells which seem to be typical for calm and shallow water, e. g. the Lampaniae (L. multiformis Lischke and zonalis Lamck). It is therefore not astonishing to find near this part of the coast, on the low grounds which are cut by the canal joining the bay with the harbour of Yokohama, those alluvial deposits which indicate the calmest and most stagnant waters. Of course these peat-deposits are truly alluvial, as is clearly shown by the underlying pebbles, to some of which recent oysters are attached, which however in their origin have been certainly diluvial. Most of these pebbles at least form a diluvial layer which only in its upper parts seems to have been greatly affected by alluvial waters. The lower parts of the river-beds are likewise more clayish—and in some instances peaty—within the bay than on the eastern coast, where sands prevail often to some distance from the sea. This cannot be well explained by any difference between the river-courses themselves, but it is perfectly accounted for on the supposition that the same causes acted upon the land before it reached its present extension, at a time when the shore was situated nearer to the base of the bluffs, but when the elevated bluffs were already in existence and opposed to the low-level-plain. This period, of course, belongs to an earlier part of the recent or alluvial age.

This fact which will be treated in the concluding chapter of this memoir, leads us to consider the difference exhibited by the alluvial sediments according to their age. It may be said, however, that a distinction between older and younger deposits of this kind cannot be made everywhere—just as we have seen already in the introduction that on the slopes of the mountains encircling the plain of Tokio we cannot draw a certain line even between the two main divisions of the quaternary age, the diluvial and alluvial formation. Indeed the distinction of old and new alluvial deposits is confined to broader river-valleys, whenever they show the phenomenon of *terraces*, slight as their height and importance may be. By examining our river-beds, we shall very often recognize such terraces, and it would be perfectly erroneous if we should confine that name to the very large, nay gigantic terraces of some of the river-valleys of North America. In any part of the European continent, for instance, we find terraces along the river-banks of a few metres of height, and this seems to be indeed the rule, whilst those very high terraces apparently have an exceptional character.

The phenomenon is moreover in perfect conformity with all the laws which concern the action of water, erosion &c, the water of any river always tending to cut into the soil and to flatten and lower the parabolic line which as a rule is formed by any freshwater-course. Wherever the land is rising, and the level of the upper part of a river-course is raised above the level of the mouth, of course the phenomenon is rendered more obvious. I have already mentioned, and shall recur to this fact, that such is the case in Japan, or at least in the environs of Tokio. We may not be astonished, therefore, to find terraces along many of the larger rivers mentioned in the first chapter, among which the Tonegawa may be said to be a good example, although terraces are formed along the banks of almost all the rivers of the Tokio plain.

Of course the deep incisions made by the rivers in the middle and upper part of their valleys do not strictly, at least not exclusively, belong to the formation of terraces, and this is easily seen from the very slow but unvarying deepening of the river-beds themselves within the broader parts of the valleys. We cannot deny, however, that a part of this action at least belongs to the terrace-period. Most likely in the upper parts of the valleys this action began already at a time anterior to the alluvial era, continued during all its earlier part, or during the terrace-era, and continues still during the later part of the alluvial age.

In such cases where we may trace the limits of the terrace formation, we shall be very often aware of lithological, or mineralogical, differences between its deposits and those anterior and subsequent to it. During the diluvial age conglomerates are of frequent occurrence—as the following chapter will also elucidate—alternating with sands and clays. This is sometimes, but comparatively seldom, the case also in the terrace-formation, in which *sands* are more common. It differs by this character also from the more recent deposits which are richer in clay, peat and calcareous layers, and this difference is well explained by the more uniform movement of the waters which made those older deposits. Though in the average the velocity of the waters was not greater—perhaps somewhat smaller—at that time than it is now, yet the want of stagnant parts of the river-courses and the comparative uniformity of the slope as well as of the breadth of the valleys could but have such consequences. They are, however, less conspicuous in the plain of Tokio than in many other countries, for instance in the plain of northern Europe, where the bulk of the older alluvial deposits (corresponding to the American Terrace- or Champlain-period) is almost entirely built up by the so-called 'Thal-Sand,' or sand of the valleys.

CHAPTER III.

THE DILUVIAL DEPOSITS.

In the introductory chapter we have already sketched the mode in which the very important older quaternary strata have been deposited under the surface of the sea at a period anterior to the present (or alluvial) age. These strata contain in some cases remains of extinct animals, but in Japan do not betray any traces of glacial origin. Owing to the horizontal position maintained by these strata from the beginning, they have been cut through by rivers and rivulets; and along the banks of the streams, as well as in road-cuttings and banks along the sea, we have geological sections through these diluvial strata which sometimes expose their whole extent. In many cases, which have already been alluded to, and which will be mentioned in the following chapters, these sections are of the highest value for our investigation; whilst, in other instances, we have the slopes made less steep by superficial waters which always tend to sweep down parts of the soil and to obliterate any sharp contrasts of level in the surface of the earth. In consequence of this action there are also cases in which the upper parts of the diluvial formation have been sliding down along a sloping hill; as a rule, however, the upper strata only cover the surface of the higher plain.

A few instances, moreover, are to be noted where the lower part of the formation is, as it were, a little swollen, and therefore appears at the surface. This is mostly the case where sands prevail, and we may say, that in such localities the upper part of the diluvial deposits is wanting or reduced to a very thin layer scarcely to be perceived in a geological section and often entirely mixed up with the fertile and humose soil supporting the vegetation. It is also impossible to say whether fossil remains found in such localities really belong to the upper part of the diluvial formation, even if they are found directly under the fertile soil—as this has been the case with one or two of the remains of elephants to be mentioned below. As all those remains, about which we have more accurate information, have been either found in deeper cuttings or have been dug out under water, it will be safer to refer all the elephants' remains to the lower part of the diluvial formation.

The *upper part* of the diluvial deposits is surprisingly uniform, and the contributes much to the even character of the surface of the upper plain. In the cuttings we see almost invariably a stratum of 3 to 6 meters thickness overlying the rest of the diluvial formation.

This upper stratum is a somewhat coarse clayish sand of a reddish brown color. An analysis made under the direction of Professor Atkinson, of the Daigaku, by one of the students, gave the following result.

COMPOSITION OF THE LIGHTER PORTION OF SAMPLE AFTER LEVIGATION,

24,40 percent of the whole.

Siliceous acid, $Si\,O_2$	65.15 %
Sesquioxyd of aluminium, $Al_2\,O_3$	19,20
d° of Iron, $Fe_2\,O_3$	7,76
Lime, $Ca\,O$	1,49
Magnesia, $Mg\,O$	0,12
Phosphoric acid, $P_2\,O_5$	0,20
Loss on ignition	6,03
Total	99,95 %

It is remarkable that 'alkalis appear to be wanting'—a fact which in itself serves to refute the notion that there is a small amount of phosphoric acid in the Japanese soils. The superficial diluvial layer, often overlying very loose sand or conglomerates, and always subjected to a degradation by the rain-water which is mostly kept for a long while on or near its surface—the soil being but little pervious to water—, has lost its alkali-salts, and yet a tolerable amount of phosphates is left in it. It may be added that not all such soils are free from alkalis, the amount of carbonate of potash being sometimes more than one half percent and that of carbonate of Soda at least more than 2 per mille. The sand, comprising the *coarser parts* and (amounting to 75,52 percents of the whole, contains

Siliceous acid, $Si\,O_2$	69.885
Sesquioxyd of aluminium $Al_2\,O_3$	15.285
d° of Iron, $Fe_2\,O_3$	8.645
Lime, $Ca\,O$	1.875
Magnesia, MgO	traces
	95.690

and therefore contains decomposed silicates together with quartz, the silicates having chiefly furnished already clay and limonite. The presence of a larger quantity of this last-mentioned substance is shown also by the color of the soil.

The stratum which does *not quite conformably* overlie the lower part of the diluvial deposits shows clearly that there was a gradual and gentle passing from one part of the formation to the other. It may be remarked that slight unconformabilities often occur within the diluvial formation. Though they are by far less numerous and less important here than in all those places where we are to assume a glacial action, yet they are to be observed, and, at the same time, are in perfect agreement with the nature of the diluvial formation. For this formation is one of rather quick destruction and turbulent deposition of soils in comparatively shallow seas and near the shores—a fact which accounts for their being spread chiefly along the present shores or at least in wide and low plains bordering the sea on one side. The unconformability in question, however, is more striking and appears so often and so strongly that we are indeed obliged to divide more sharply the upper from the lower diluvial layers.

The mode of deposition explains also fully the great *variety* which we find among the *lower* diluvial deposits even within narrow limits, all of which may be determined as a mixture of conglomerates, sands, clayish sands and clays, of which sometimes the one and sometimes the other prevail.

Now the uniformity of the uppermost layer gives another reason for separating this deposit from the rest, and one more may be derived from a striking character, the want of any traces of true stratification *within* it. This want may be explained in a different way; but by far the most probable explanation seems to be that those uppermost diluvial deposits, though they correspond exactly, lithologically, to the *loam*, and differ from the true, '*loess*' of the Europeans by not having a sufficiently large amount of lime, have had an origin analogous to that of the large deposits of loess found by Baron von Richthofen in Eastern Asia.

Those loess-deposits had accumulated by the action of *wind*, according to theory of von Richthofen, and though this theory, which points out the *subaërial character* at least of a very great part of the loess, is a very new one, yet it has been discussed already most copiously and may now be regarded as fully confirmed.

Far as I am from assuming an exclusively subaërial origin of any loess, and ready as I am to admit that there are loess parts, e. g. the lowest strata around the larger basins filled by it, which do *not* exhibit any signs of subaërial origin and are undoubtedly stratified (showing alternate layers of loess and conglomerates, or of loess containing many loess-shells, and other parts devoid of them), yet the majority of the loess-deposits remains, and corroborates the above-mentioned theory. Slight as the upper diluvial deposits of Japan are if compared with those of China and Mongolia, it is scarcely possible not to admit an analogous origin, and this assumption moreover is in perfect accordance with the *age* of the analogous European deposits which we know to a certainty were formed at the conclusion of the diluvial epoch.

The want of lime, which (as the analysis shows) is not a complete one, is of course much less important than the fact of the analogous mode and period of deposition.

This want of lime may be explained either by a comparative scarcity of rocks furnishing lime by their detrition and decomposition, or by a subsequent loss of it which has very often been observed in such diluvial deposits as are placed next to the surface and therefore have been exposed for a long time to the action of atmospheric water. All the minute researches on the superficial, and above all on the superficial quaternary sediments confirm this theory most completely, a theory which as far as I know was first published by a German author Professor Dr G. Berendt at Berlin (as well in his papers published by the 'Geologische Landes-Anstalt' at Berlin, as in some papers contained in the periodical of the 'deutsche geologische gesellschafit'). I have had many opportunities when surveying and mapping in the Province of Brandenburg, Germany, to observe the correctness of this theory. In many instances only an upper layer, of irregular extent, and limited by an undulating line at a little distance from the surface of the soil, has lost its lime; but in some other instances, where the thickness of the marly soil was not very great, and where sands or conglomerates pervious to water were underlying it, it is seen to be completely deprived of lime.

It needs scarcely be added that the *loess* is very often subjected to the same law and very often has, in its superficial parts, lost that higher percentage of lime which is always found in normal loess. Now moreover we find in such soils, out of which the lime has been washed by the atmospheric water, a certain degree of accumulation of clay in the lower and a comparatively small amount of it in the upper part. This, of course, is also quite natural, as, in the process of outwashing, the soil becomes loose and the clay can also be washed out of it to a certain degree, and thus carried down and, in many instances, accumulated in the lower part of the outwashed soil. In other cases it may be even taken down into loose sands &c. underlying the smaller layers of marly and afterwards loamy soil.

That the sandy clayish soil of the upper part of the diluvial formation of the Tokio plain has no lime and a higher percentage of clay than other soils of an analogous origin and of the same geological age, cannot be surprising, even if we do not take into consideration that all the true loess, at least that of Europe, has been derived from rocks worn and ground by glacier action.

Rocks thus reduced to powder would be much less exposed to loss than rocks converted into detritus by the action of water alone. Both causes combine to diminish the amount of lime and to increase the amount of clay, the first being about 14 % in the loess as well as in the glacial marly mud (bond-moraines of the Swedish authors) covering a great part of the surface of the northern European plain, and only about 2 % in the upper diluvial deposits of Japan, whilst the sesquioxyd of aluminium, about 8 % in the loess &c., rises to the double amount in the latter. In the other substances, especially in the amount of silica and iron, there is no essential difference.

For instance, we have 62½ percent of siliceous acid in the loess and 65 in the Japanese soil. The only difference still to be noticed is the presence of a small percentage of alkalis (2.3 totally) in the loess—a difference which, as has been already stated, is doubtlessly due to the dissolving action of atmospheric water just as well as the small amount of lime.

The soil in question is practically of a very great importance. It renders the plain of Tokio fertile even in those parts which are not situated in river-valleys and depressions (filled with the alluvial deposits sketched in the foregoing chapter); although not all of the higher plains are cultivated, yet their vegetation is almost everywhere a copious nay luxuriant one. The tree-plantations and the woods are thriving, the groups of trees round the villages and temples are quite as richly developed as those in the lower grounds, and even the bamboo is scarcely inferior to that of the marshy djungles. The Matsu- and Sugi-trees are very often met with in large and beautiful specimens. But above all the fields containing barley, wheat, buckwheat, the various kinds of millet, beans, Sato- and Satsuma-potatoes and other vegetables are very fertile and contribute in a high degree to the almost luxuriant crops which Japan enjoys in spite of its singular and, as a rational agronomist ought to say, not quite correct system of husbandry. Indeed except that quite correct idea of confining the rice-farming to the low grounds, which is said to be a divine suggestion, the author must confess to have seen nothing praiseworthy in the agricultural system of the Japanese, although much that deserves praise in the zeal and skill exhibited by the workmen themselves. It may be safely said that even this diligence and industrial cleverness of the farming people would not suffice to provide them with good crops if the soil was not fertile in itself. Among those sorts of soil which are to be highly valued, the upper diluvial soil is one of the best and at the same time one of the most widely spread, as it covers a very large portion of the Tokio plain. Valuable, however, as this soil is in respect to farming, it is rather unfavorable to civil engineering; and to a great part the very bad state of the roads of the environs of Tokio is due to the same cause. Indeed it is surprising to see, in the very neighbourhood of a capital of the largeness and importance of Tokio, the roads so bad and, I may say, so primitively constructed that any large rainfall, any thaw in winter unvariably makes them nearly impassable. This would, perhaps, not be the case, if the roads did not cross, in the Tokio-plain, very often and for long distances the sandy clay of the upper diluvial formation, which is impervious to water. In dry weather, the roads made of this soil are tolerable, and so the inhabitants are led to believe erroneously that the roads are not very bad and that the weather is the cause of those disasters and hindrances in travelling which—as is well worthy of notice—occur not only in side-roads, but in the most important high roads. Indeed some of the governors of provinces and districts especially in the north of Tokio have begun to improve the roads partly by digging out ditches and moats for drainage and to correct the road itself by the addition of gravel and pebbles or fragments of stones. But even such primitive improvements are far from being frequently made, and wherever they are not, the roads on the high-level plain between the valleys are equally bad with those on the embankments between the rice-fields or on the small dikes crossing the low grounds or running along the river-banks.

The lower part of the diluvial formation is practically far less important, though it has, as a rule, a much greater thickness. It may be added also that it varies much more lithologically and contains either impure conglomerate or sand or clay, and sometimes even an admixture of tufaceous parts. Very seldom, however, is it uniform in its totality, for we very often see the inferior part of it to be clayish whilst the upper part is formed of conglomerate. As a rule, we may say that conglomerates predominate. In many places we see 6—8 meters filled up entirely by them and it is very seldom that they are entirely wanting.

Even where clay prevails, small layers of conglomerate are inserted between it, and pebbles or other coarser objects are often intermixed with the sands or clays. We may besides add that these sands and clays, together with the conglomerates, are always *stratified;* the stratification of sands and conglomerates often passing over into those undulating layers so often seen in them, whilst the clays are perfectly horizontal and exhibit many smaller and larger strata.

Though it seems very difficult, after all, to give a good idea and a picture of the diluvial strata, we add a small sketch of the bluff next to the railway station of Kanagawa (NE from it). It exhibits the horizontal surface of the upper plain, the upper diluvial sandy clays unconformably overlying the lower diluvial strata of clay, conglomerate and sand, which are not of a very great thickness at that place and unconformably overlie the sedimentary rocks described in the following chapter. (Pl. I fig. 1).

The practical use of the lower diluvial deposits is confined mainly to the *conglomerates,* which, if tolerably pure, are frequently dug out for engineering purposes. Less important is the use of some of the clays for making bricks, or tiles, or even—in small layers of purer quality—for making pottery in villages whose inhabitants are accustomed to draw the materials required for it from their neighbourhood.

The admixture of the lower diluvial strata with the tufas belonging to the volcanic rocks of the southern coast near Yokohama etc. is not to be omitted, although, within the limits of quaternary rocks, it is by far less extensive than in the tertiary formation. It may be said to be almost fully explained by parts of the tertiary tufaceous rocks being destroyed and deposited again by the diluvial sea. Although the outbreak of ashes and lapilli continued through the present era, and must necessarily have brought some material of that kind between the sediment of quaternary origin, yet by far the greater part of that admixture seems to be a secondary deposit and carried over from tertiary tufaceous strata to the quaternary ones. The volcanic energy, indeed, must have begun to abate long before the present era, and most likely about the end of the tertiary and before the very beginning of the diluvial epoch.

The organic remains of the diluvial formation of Tokio and its environs are not very numerous.

First we must mention the fragments of wood, half decomposed or even entirely converted into brown coal, which frequently occur in sandy or clayish diluvial beds, especially near their lower limit. Prints of leaves are but sparely distributed among those fragments of stems, or of roots, all of which belong to recent species. This is of course to be expected as even most of the youngest tertiary fossil plants do not belong to other than surviving species. The leaves occuring most frequently are oak—and ash-leaves, those of maples, chestnuts, whilst the fragments of wood belong to the sugis or cryptomerias and other coniferous plants now living in Japan.

The molluscous shells, which may be divided into land-and fresh-water shells (mostly Helix, Melania and Cyrena) on one side, and marine shells on the other, also belong mostly to surviving Japanese species. This may be even exclusively said of the land-and fresh-water shells, but not so exclusively of the marine shells, because among these there are some which have been washed out of tertiary beds and redeposited. In this case, of course, the preservation of the shells is inferior to that of the shells of the tertiary layers themselves; fragments prevail, and that sort of fresh lustre which is very often found in alluvial shell-deposits of any origin, is entirely wanting, just as it is only exceptionally seen in the tertiary beds. The same may be said of course about crabs and crayfish, star-fish, corals and bryozoa, whilst reef-building corals, as scarcely needs be mentioned, are wanting in all the quaternary deposits.

Among the terrestrial animals we have only mammals, and even among these the number of species is rather limited. Stag's antlers have been found, but it has not been ascertained whether they belong to Cervus Sika Sieb. or to some other species extinct in Japan, so that it would not be allowable to speak of the existence of any such species. A great many vertebrae of Cetacea have been collected, and as far as may be concluded from the descriptions of the localities, partly in diluvial strata; for whilst in some instances it is reported that they have been found in deep valleys, yet in other cases the reverse is asserted. The species they belong to, could be only very imperfectly determined; in one case a skull was dug out which belongs to Phocaena globiceps Cuv. whilst in another one the teeth which had been found are those of Phocaena Orca L. Several other species will no doubt be added to this incomplete list.

Last, not least, the Elephant-teeth and jaws are to be mentioned, which belong to *two* different species.

FIRST SPECIES.

1) Four branches of the jaws of one—apparently young—animal have been found not exactly within the limits of the district we are describing, but are well worth mentioning in other repects. The number of plates is comparatively small; the teeth moreover, in spite of being very large, are undoubtedly milk-molars. There are two in every branch, and the posterior one is not ground at all, but has the ridges or plates rather prominent. I count 5 plates and one (posterior) talon in the anterior teeth of the lower jaw, four plates and one (posterior) talon in the anterior teeth of the upper jaws; the anterior side is much worn and partly destroyed. The length of the lower teeth is 66 millim., that of the upper 50 m'm, the breadth of both is 38 mm. The posterior teeth are not fully grown out of the sockets, and their posterior end is not visible. The number of the plates visible is 5 in the lower jaw, with one (anterior) talon. In the upper jaw there is one plate less. In both jaws one plate, or perhaps one plate and a talon, must be added to the number of the visible plates. The length is 50 mm.

The small number of plates is remarkable in so large teeth (whose entire height, however, is comparatively small; it is visible in the posterior part of the left upper jaw, and by this circumstance alone the teeth are proved to be milk-teeth). This fact excludes every possibility of regarding this specimen as belonging to the second species to be mentioned, viz. E. antiquus. Besides, the solidity, and the little deviation from the oblong form exhibited by the plates and the ridges corresponding to them, together with the form of the mandibles, as far as they are preserved, make it certain that we are dealing with *Elephas meridionalis* Nesti. This species has been establisted by Nesti in the Ann. Mus. d. Firenze, vol. 1, p. g, pl. 1, f 1 and 2, and the name is synonymous with E. Malbattu and with 2 names given also by Nesti, viz. E. minutus and E. minimus, ib. pl. 2, f. 1. The latter of these two names is not to be confounded with an E. minimus Giebel, which is nothing but a young E. primigenius Blmb. The comparatively large size of the jaws of the very young animal, and, as I said, the form of the lower jaws attest also this relationship. The mandible could be directly compared with a plaster copy of one of the standard specimens of Elephas meridionalis, and showed no difference in any proportion, being only as much smaller in all dimensions as may be fully explained by the young age of the individual. The so-called gutter is of the normal size, the angle of the branches of the mandible equal to 115°. The entire mandible is 390 mm long. 300 mm wide at the posterior end. The first 215 mm open more slowly (the interval reaching only 70 mm, whilst the breadth of the bones is 100); the anterior extremity is 70 mm broad (in the median line).

The locality in which this specimen was found is in the neighbourhood of the Biva-lake, province of Omi. Further details about the way in which the bones were found and how they were deposited, I have not been able to ascertain.

2) As this first specimen, though the completest of all I have seen in Japan, does not belong to an adult animal, another one is of importance, though topographically still farther separated from our area. It has been found in the province of Iyo, in the island of Shikoku, and is a huge last molar tooth colored very dark brown, almost black, with all the lustre of the fresh tooth, but covered in a few places by serpulae and small oyster-shells. It belongs to the right branch of the mandible and has a total length of 200 millimeters, a breadth of 90 and reaches a height of 110. It contains 8 plates, the two last of which are small, the penultimate worn very little and the last one not at all. The crowns are broad, highly elevated and conically ascending; their length reaches 75 millimeters.

3) The third specimen of Elephas meridionalis Nesti is a lower jaw found in the year 1868 near Yokosuka (Sagami), which therefore belongs to the district in question. It was taken to Paris by Dr. Savatier, and is mentioned by Antonio Stoppani in his 'Corso di Geologia,' vol. 2, p. 677 (Milano 1873). Together with the remains of the next species it proves the coëxistence of these *two* species of Elephas not only in Japan but also in the environs of Tokio, just

as in Italy and other parts of Europe.

The definition of the beds in which this remain of Elephas meridionalis was found, as an 'alluvione' (l. c. in Stoppani's Corsa) seems to indicate that we have to deal with those quaternary deposits which are contemporaneous with the alluvial as well as the diluvial era, and which have been discussed in the introductory chapter. At all events the expression which Stoppani uses on this occasion, viz., 'terreno glaciale,' or glacial bed, is not founded on any strict observation, and means nothing but what we call the *diluvial* age of those beds. It may be observed that Stoppani assumes far too much in referring all these beds to a glacial origin.

SECOND SPECIES.

1) A tooth of 11 plates and 2 talons, 45 to 50 millimeters broad and 100 millim. long with a height of 125 mm in maximo, is a true molar, though not the last one, of the upper jaw of a comparatively large, though not perfectly full-grown animal. The narrowness of the crown together with the rather large number of plates, and the slight dilatation of the plates in the median line of the tooth, which in spite of the oblong (nearly linear) shape of the plates is distinctly to be seen, makes it quite certain that we have to deal with Elephas *antiquus* Falconer. The comparatively less solid and much folded enamel-coats of the plates give a further difference from E. meridionalis Nesti, which is chiefly distinguished by the smaller number of plates; E. primigenius Blumenbach, on the other hand, has no dilatation of the plates in the central part of the tooth, though in other respects its characters are quite similar.

This specimen has been recently found in the Province of Kishin, not far from the southern extremity of the main-island, south of Osaka. Although, like the first specimen of E. meridionalis, it does not properly belong to the district we are describing, yet the distance of the locality in which it was found is not so great, that it need be excluded from our list, which is far from being a long one.

2) The second specimen which undoubtedly represents an upper last molar of a somewhat older individual, is 140 mm long and 50 mm broad with 125 of height in maximo, and has 14 plates. A part of the tooth (anteriorly) being broken off, we cannot say what has been the real number of plates. Most likely, there were but very few more. The plates exhibit all the characters of *Elephas antiquus* Falconer; the enamel-layers are still more folded and comparatively weak.

. This specimen has been found at Kihara Mura, a village bordering the above-mentioned lake, the Kasumiga-Ura, north of Tokio (Province Hidachi), and is said to have been found under the surface of the water.

3) The third specimen, a mandible, found in a deep cutting—according to what is added, most likely a gravel-cutting—near Yokosuka (Province of Sagami)

is still more suited to confirm the determination of the foregoing specimens. Its crown is narrow, 45 to 55 millim., whilst the tooth is 165 mm long and has 14 plates of the same nearly oblong form with a marked, though not very large dilatation in the middle.

4) If the last mentioned specimen belongs already to the Tokio-plain, the fourth one has been found in the metropolis itself near Yeddonbashi, in the diggings made for the construction of the post-office situated in the neighbourhood of this bridge. It is a right upper first true molar, not very large, 183 millim. long, 55 broad (crowns measuring up to 50, but mostly not more than 40 mm), and has a triangular shape in the profile-view, the highest part reaching 140 millim. The number of plates is 11, with 2 talons (the posterior of which is more distinctly visible than the anterior one); the enamel is often and deeply plaited.

Altogether, these 4 specimens leave no doubt whatever about their belonging to the true Elephas antiquus Falconer, a species formerly confounded with the mammoth, but separated from it for sufficient reasons.

This was chiefly done by Falconer in an essay published after his death, 1865, which is mostly referred to by A. Leith Adams in a paper published by the Paleontological Society of London, 1877.

These Proboscidean remains show, I dare say, to a certainty, that during the diluvial age there were Elephants in Japan which belong to palæarctic quaternary forms.

They seem to have been rather abundantly spread at least in the central part of the main-island, but they do not show close relationship with the Siberian elephants, as they do not belong to truly boreal forms indicating a very cold climate. Elephas antiquus, though found in localities not far distant from the area of the mammoth (e. g. in Thuringia) and sometimes even within its area (in England), has not been found in any truly glacial deposit. Still less this is the case with Elephas meridionalis.

The elephants of the diluvial deposits of Japan form, after all, a valuable link between the tertiary and recent faunae, and confirm what is said in the first chapter about the close resemblance of the western and eastern part of the palæarctic region.

As to the relations to American elephants, the Elephas americanus might be compared, which also belongs to a warmer climate. It is at all events very closely allied to Elephas antiquus; but its enamel plates are asserted to be less crowded. As the discussion about this object would lead us too far, I do not enter it; the less so, as we may quite safely refer all the Japanese specimens to palæarctic diluvial species, and moreover to such as belong nearly to the same latitudes.

It has been already said that there is no sufficient reason for extending the era of the Japanese Elephants beyond the reach of the *lower* diluvial deposits, to which the same species mostly, if not totally, are also confined in Europe.

CHAPTER IV.

THE TERTIARY DEPOSITS OF OJI.

In the introductory chapter, I have already alluded to the remarkable fact, that there is a great difference between the diluvial beds and the strata beneath them. As a rule, these diluvial beds are also divided; we can often very easily find a line which separates the upper diluvial loam from the lower diluvial beds, and which is truly a line of *uncomformability*. This is quite natural, as the upper diluvial formation—according to what is said in the preceding chapter—has been deposited in a perfectly different way. The lower diluvial strata, not intermixed with any products of glacial action, are eminently conformable. Thus another line of partition, another true line of ***uncomformability*** becomes highly important. It is formed at some distance from the surface of the soil, although, of course, that distance varies and is often so great that the lower strata are not exposed. The appearance of this line is very nicely exhibited in some of the localities which I am to mention, e. g., at Oji, Fig. 4 and at Kanagawa, Fig. 2 & 3.

At Oji, the very lowest part of the exposure shows the line of position and the strata below it in a similar way, as they are seen in deep cuttings. At Kanagawa, the line of unconformability appears much higher, as it does also in a great part of the bluffs near Yokohama. Those at Kanagawa, a portion of which I have designed, are very near the Kanagawa station, and between the railway and the sea. They give perhaps the best idea of the true nature of that line, which here takes an undulating course, and so becomes very clear, although there is no visible difference in the angle of dipping between the two formations. In other instances we can very easily recognize such a difference; for instance, in the bluff of the sea-side south-west of Yokohama. The difference is more than 4 degrees, and amounts up to 6 degrees, the lower strata being inclined to the west whilst the upper strata continue to be horizontal. This difference would be indeed perfectly sufficient to prove that this unconformability is more than what is usually seen between two subordinate divisions of a formation, even if the angles of dipping of the inferior strata was not sometimes greater. At Sukegawa and between this place and the town of Mito, it is very often about 10°, and never below 8°, whilst in some places it rises to 14°. the direction of dipping being here nearly or exactly north. Thus we find the lower formation undulating throughout, and its uppêr limit is quite irregular in consequence of the erosive action of water during a subsequent period, after which another sedimentary formation was deposited.

If we do not confine ourselves to the plain of Tokio, we find even higher angles of dipping within the formation immediately underlying the quarternary deposits. In the province of Chichibu, the sandstone, conglomerate and shale, mentioned in the introductory chapter, have an angle of dipping mostly of 30°, or rather from 30° to 40°, directed towards W 30° E; in a few instances, near the borders of the basin filled by those strata, it amounts to 55° or even a little above, the direction changing to due North. As it has been already stated and will be discussed below, the fossils contained in these beds are to so great an extent the same as those of the strata which in the Tokio-plain appear directly below the above-defined line of unconformability, that there can be no doubt about all these layers belonging to one and the same formation.

This, of course, could not be affirmed without some deeper study of the fossils, and I think, it is quite necessary for the advancement of our knowledge of this highly important formation to give the results of the observations thus far made upon it, without attempting for the present to make them quite complete. Indeed, it does not seem advisable, to extend at once those researches to other animals than mollusca, or to the fossil plants occasionally found in these *uppermost tertiary* deposits of the environs of Tokio, as we may call them quite safely. Although we find almost always fragments of stems of monocotyledous, dicotyledous and gymnospermous plants, and although a few nice small specimens of corals, some sea-urchins, as e. g. Echinocyamus and Scutella found at Oji, and even occasionally, for instance in the province of Mino (Togari and Tsukiyoshi) some crabs or fish may be found between the remains of mollusca, yet the number of the latter so far exceeds that of other organisms, that we may now confine our attention advantageously to an analysis of the mollusca.

In giving the list of the fossil shells, I think it advisable first to separate them according to the localities. I hope thus not only to leave no doubt whatever about the uniformity of all those localities and shell layers, but also to give a full account of all the facts peculiar to each of them.

The locality first to be mentioned is Oji, see fig. 4, a village in the neighbourhood of Tokio, situated beyond that part of the town which is called Hongo, and nearly N.N.W. from the centre of the town. The distance of Oji from Nihonbashi is about 2 Ri., from the centre of Hongo about 1 Ri (one Ri being nearly equal to 4 kilometres).

Arriving at Oji, we see first a cutting containing sandy conglomerates of the lower diluvial formation under a cover of the upper diluvial loam, next to the road descending from the height of the plateau down to the rivulet passing through the village. After crossing the river and ascending the plateau on the other side, we have the same formation, viz., upper and lower diluvial strata. We see here, however, some clayish layers between the conglomerates and sands. Passing on a little more to the west, we find the deep cutting in which a corn-mill is situated, and in this cutting, very near its bottom, are those shell layers, which are richer in shells, individuals as well as species, than any of the other localities to be mentioned. It is obvious from the very first glance at the place or at its figure (Pl. I, fig. 4) that we cannot possibly have to deal here with any accumulation of shells made by men; the thickness of the diluvial deposits, here still more clayish, being not less than 7.3 meters. Of this thickness, 3 meters belong to the upper diluvial loam (which itself is covered by 0.5 to 1.5 meters of soil), and 4.3 meters to the different parts of the lower diluvial formation (2.3 clay, 0.3 conglomerates and 1.7 clay again, measured from above.)

The shell-layers are found immediately below the line of unconformability which is sufficiently undulating to be recognized; they slowly pass into impure dark clayish strata, somewhat poorer in organic remains, and in the lowest part containing almost none at all. Those clays are visible in a thickness of 3 meters measured from the shell-layer, which, in the average, is not thicker than 0.5 meters, though sometimes rising to nearly 1 m. The difference it exhibits from the—unconformable—diluvial deposits, is of course much sharper, and above all we do not find any well preserved shells above the line of partition. There are only a few casts, apparently belonging to shells of the same species as those of the layer, imbedded in them together with fragments of wood etc. The shell layer is not confined to the mill, but extends to the north and west. Here it is repeatedly intersected by cuttings made for canals, and sometimes also it appears in the banks of the river itself. But it is not uniformly rich, as we may see in many of those places, some of which seem to have been in some instances mistaken for remains of shell-mounds. The true shell-mounds, alluded to by Professor Morse in his memoir, are, however, quite different and situated both sides of the road from Tokio to Oji, near this place, but next to a village named Nishiga-Hara-Mura. At a larger distance from the mill, the number of shells is rapidly decreasing, at least as far as the investigation of the layer could be carried on; and as all the species found in the other places are included within the number of those found next to the mill (in the steep slope seen behind the mill seen in the sketch, along the small canal, and in the tunnel to the right), I may confine myself to the following list of species found in this locality.

THE SHELLS OF THE LAYER AT OJI.

Gasteropoda.

Neptunea arthritica Valencieunes. Plate II fig. 1 (comptes rendus de l'acad. des sciences nat. 1858, vol. 46, page 761. Bernardi, Journal de Conch. vol. 6, Page. 386, plate 12, of 3. Sohrenck, Tritonium arthriticum, Nordjap. Moll. page 421. Lischke, Japanische Meeresconch. v. 1, page 37.)

Not very frequent at Oji. Recent at Hakodate; as to the generic denomination, I think it best to adopt Lovén's genus.

Trophon Gunneri Lovén.

(Index Moll. Scand. page 12, No. 84. Wood, Crag Mollusca, Suppl. page 27, t. 3, fig. 18.)

This species, recent from the boreal seas, fossil from the glacial beds and according to S. V. Wood from the Norwich Crag of England, has been very rarely found at Oji. I have before me only I specimen with 5 whorls, 2 of which are smooth, and the last of which has 11 to 12 frondiculated rib's. It is 7 mm. long and 3 mm. thick.

Nassa Japonica Adams.

(Genera Moll. vol. 1, p. 120, Caesia Japonica; id. in Ann. and Mag. Nat. History 1870, vol. 5, p. 426.—Lischke, Japan Meeres-conch. III, p. 37, pl. 2, f. 20-23.—Non Nassa Japonica Reeve, Demoulea Japonica Adams, in Reeve, Icon. Nassa, pl. 29, f. 192).

Without trying to criticize the statements made by Lischke, I confine myself here to identifying with his species one which is very frequently found at Oji, though almost exclusively in very small specimens. The turreted shape and the nice transverse striæ with broad, somewhat convex interstitional lines, go almost uniformly over the costæ and give to the surface a much less granular character than in the (equally elongated) N. granulata J. Sow. The somewhat convex and rounded form of the whorls makes this identification perfectly certain.

Nassa livescens Philippi.

(Zeitscher für Malacozool. 1848, p. 135, as Buccinum.—Dunker, Moll. Japon. p. 7 Lischke, Japan. Meeres-Conch. II, page 52, pl. 4, f. 1-3).

The same is to be said about another species of Nassa, which occurred but rarely at Oji, broader, thicker, with less convex whorls, and with coarser and more oblique ribs.

Columbella scripta, Linné.

(Syst. Nat. ed. XII, P. 1225, as Murex scriptus.—Blainville, Faune française, p. 208, pl. 8, f. 20-12, as Columbella conica.—Philippi, Enum. Moll. Sicil. vol. I, p. 225 and 227, as Buccinum Linnæi.—Kiener, Coqu. viz. p. 48, pl. 16, f. 56, as Buccinum corniculatum.—Sowerby, Thes. Conch p. 127, pl. 38, f. 101,as Columbella corniculata.—Deshayes in ed. Lamarck, vol. X, P. 175, same name.—Philippi, En. Moll. Sic. vol. II, p. 190 and 193, as Buccinum scriptum Chemnitz, Conch. cab. second ed. p. 41, pl. 8, f. 19-22, same name.—Weinkauff, Conch. d. Mittelm. vol. II, p. 36. d'Orbigny, Prodr. vol. III, p. 175. as Columbella pseudo-scripta.-Hoernes, Mollusken des Wiener Beckens, v. 1. p. 116, pl. 11, f. 12.14.—Beyrich, Zeitschr. d. geol. Ges. Tert. Moll. p. 107, pl. 6, f. 8.).

This shell known from Nagasaki and mentioned by Dunker, Lischke (Jap. Meeres-conch. I, p. 57 and 58) and others agrees with fossil and recent specimens of the species, which is eminently mediterranean. The specimens of Oji are tolerably numerous, nearly as large (15 m. m. long, 6 of which belong to the aperture, 6 m. m. broad) and of the same proportions as the European.

Olivella consobrina Lischke.

(Japan. Meeres-conch II, p. 62, pl. 5, f. 10 and 11.).

A few specimens entirely corresponding with Lischke's figure—only the coloring being deficient in the fossil shell—have been met with at Oji.

Ringicula arctata Gould.

(Otia Conch. p. 122.-Lischke, Jap. Meeresconch, v. 2, p. 78, pl. 5, fig. 16. 17.).

Small specimens of this kind were the most frequent gasteropoda at Oji, being nearly equalled in number only by the Nassa Japonica and Odostomia, and surpassed only by some of the conchifera (Tellina nasuta, Solen grandis, Dosinia exoleta. Lucina borealis, Diplodonta trigonula).

Size, proportion, callosity and narrowness of the aperture, together with the 2 folds and 1 tooth above them, and with the pointed apex, are the properties which suffice together with the proportions (length to breadth 4 : 3) and with the number of the whorls (5 +) to leave no doubt about the identity of the species found living at Hong Kong and Nagasaki. The transverse striæ, not very conspicuous even in the recent shells, are but seldom well preserved in the fossil. It seems doubtful, whether the pliocene fossil shells, which S. Wood described 1848 from the british crag under the names of Ringicula buccinea and ventricosa (Crag Moll. I, p. 22, pl. IV. f. 182) belong to the same species or not. They are much larger, the length of the largest specimens of England being at least 70% greater than that of the largest Japanese. The proportions, however, the details of sculpture and form, the teeth and folds, and the thick outer lip together with the narrow aperture do not differ. In this respect, it may be mentioned that the folds are placed comparatively lower in the average in the adult and more developed specimens, in which moreover the outer margin is more thickened. Thus, though Wood says he did not see any intermediate forms, we may assume that R. ventricosa is only the full grown stage of R. buccinea, and must be erased as a species. The analogous differences we find in the younger and older shells of Oji, only—both of them—in smaller dimensions. As for the sculpture, it is quite natural to see it better preserved in the more robust specimens, in England as well as at Oji, than in the less developed specimens. Thus, it does not appear either in the figure or in the diagnosis and description of R. buccinea Wood. To a certainty, we may say that the species of the Crag, which by some authors have been already united, are at least very nearly akin to our species. This, as Gould says, is also closely allied to 2 recent Pacific species (R. caron and propinquans), which I have had no occasion to examine.

Ficula reticulata Lamarck.

(Hist. Nat. des Anim. s. vert. 2nd ed. Vol. IX. p. 510.—Phil. En. Moll. Sic. Vol. II, p. 186.—S. Wood. Crag Moll. I, p. 42, pl. 2, f. 12.—Lischke, Jap. Meeres-Conch. v. I, p. 40.—Reeve, Icon., Ficula I, 1.).

One small specimen found at Oji.

Natica Lamarckiana Reeve.

(Conch. Icon. Natica, pl. 2, f. 6.—Lischke Japan. Meeres-Conch v. 1, p. 80.—Morse, Shell-Mound of Omori, pl. 18, f. 8).

Very frequently found at Oji, sometimes in rather large specimens, of 60 mm. in diameter and 50 mm. in height and even larger. Smaller specimens are rather common; they are not so typical in outlines, less broadened and flattened, but readily recognized as belonging to the same species when compared with the adult form. The adult specimens have not been found in sufficient number for comparison with the Omori-Mound-specimens. They are, in the average, between the two figures given by Morse, but nearer to the older form.

Scalaria clathratula Montague (Turbo).

(Test. Brit. Vol. II p. 297, and suppl. p. 124.—Sowerby, Thes. Conch, vol. I, pl. 33, f. 47.—S. Wood, Crag Moll. I, p. 94, pl. 8, f. 19.—Forbes and Hanley, Brit. Moll. III. p. 209, pl. 70, f. 384.—Jeffreys, Brit. Conch IV, p. 97.).

The shell, which (as e. g. Weinkauff states in the Conchylien des Mittelmeeres v. 2, p. 238) has not always been correctly determined, seems not to differ from S. Trevelyana (Leach) Sow., Thes. I, p. 100, pl. 35, f. 129. Compare S. Wood's Crag Moll. l. c. f. 20 and Supplement, p. 58, pl. IV. f. 6. The differences are not given uniformly by the British authors, S. Trevelyana being not constantly more elongated, nor S. clathratula having the ribs less angulated at the upper end. The aperture is also obliquely elliptic in both. The small specimens found at Oji do not differ at all from the Crag specimens. As for the mediterranean and fossil Viennese specimens, I leave the question unsettled.

Scalaria cancellata Brocchi.

(Coqu. Subapenn. p. 377, pl. 7. f. 8.—S Wood, Crag-Moll. I, p. 95, pl. 8, f. 22, and Suppl. p. 59, pl. 4, f. 2.).

Although I can not compare the very scarce Oji-specimens with Brochi's figure, or subapennine originals, there can be no doubt about their belonging to the same species with the Crag-specimens. The margin of the lower volution, the slight convexity of the whorls, which is quite obvious in spite of the rather deep suture, the large number of ribs and transverse striæ producing the reticulated surface, all agree. The size is very little above that which Wood indicates (reaching 12 m.m. in length and nearly 4 in breadth).

Monoptygma puncticulata Gould.

(Otia conchologica, p. 149.—Syn.? Monoptygma eximia Lischke, Malakozool. Bl. vol. 19, p. 103, June 1873, and Japan. Meeres-Conch. v. 3, p. 59, pl. 3, f. 4-6.).

A few small fragmentary specimens of this subulated shell (length to breadth as 3 : 1), with flat, transversely grooved whorls, deep suture and small aperture, have been found at Oji. Though a little imperfect, they show complete identity with Gould's diagnosis and description. Whether the above named species of Lischke's is identical, I leave undecided.

Monoptygma striata Gray.

(Sowerby Thes. Vol. II, p. 816, pl. 172, f. 18.).

This species is thicker, less slender (length to breadth nearly as 5 : 2) and has an obtuse apex, a little less crowded transverse lines, a wider aperture, and a more conspicuous twisting of the columella. It must be, therefore, separated from the foregoing species, though it has the same smooth embryonal whorls and is also very similar in appearence. It has been still more rarely met with at Oji.

Odostomia planata Gould.

(Otia conchol. p. 148).

The comparatively large, elongated and pyramidal species (I measure it up to 7.5 mm. in length, and 2 mm. in diameter, 40% of the axis equalling the aperture with a little more than 8 whorls) is found in abundance at Oji, though mostly of considerably smaller size. Just as the characters given by Gould require, it is smooth, the whorls are flat, the aperture is oval, the lip sinuated, the columellar fold strong, and the basis perforated.

Odostomia subplanata Gould.

(Otia Conch. p. 148).

The species, like the foregoing one found living at Hongkong, was also, though not so frequently, found at Oji. It is much smaller and not perforated, the whorls more convex, less numerous and more quickly tapering to the apex. The size of the fossil specimens of Japan is exactly that which Gould notes, viz., 2.7 mm. in length or somewhat above, 1 mm. in diameter.

Eulima subulata Donovan.

(Brit. shells, vol. 5, pl. 172.—Forbes and Hanley, brit. Moll. v. 3. p. 235, pl. 92, fig. 788.—Jeffreys, brit. Conch. v. 3, p. 208.—Philippi, Moll. Sicil. Vol. II, p. 134. S. Wood, Crag Moll. I, p. 97 pl. 19, f. 3 and Suppl. p. 66.—Koch and Wiegmann, Moll.-Fauna. d. Sternberger Gestines in Mecklenburg p. 95. pl. 3, f. 4.).

The long, subulated, almost cylindrical form of the shell, together with the flatness of the whorls, which have in fact but a very narrow belt in their lower part tapering towards the suture, distinguish this species, which is very rarely (and scarcely ever in entire specimens) found at Oji, from all the other species described from the Pacific coasts, and other localities. The shell is said by Philippi, Merian, Speyer and other authors to occur in the German upper oligocene (lowest miocene) strata.

Chemnitzia elegantissima Montagne.

(Test. brit. Vol. II, p. 293, pl. 10, f. 2, and Suppl. p. 124.—Philippi. Moll. Sicil. Vol. II, p. 136.—Forbes and Hanley Brit. Moll. v. 3, p. 283, pl. 93, f. 1. 2.—Syn. Odostomia lactea Jeffreys, Brit. Conch. IV, p. 164; Turbonilla elegantissima. Mont. in Weinkauff's Conch. d. Mittelm. Vol. II, p. 207; ? Ch. Jeffreysii S. Wood, Crag Moll. add. pl. f. 14, Suppl. p. 184;—? Koch and Wiegmann, Moll. Fauna d. Sternberger Gest. p. 103, pl. 3, f. 9.).

The shell, as large and nicely scruptured as from any other locality, has the longitudinal, more or less straight and strong ribs, moderately convex whorls and elongated form belonging to the species. The specimens from Oji vary greatly in all those points which led Koch and Wiegmann, and as they record, Jeffreys, to separate the Turbonilla Jeffreysii from our species; but I think it doubtful, whether this separation is correct or not. Still more doubtful is the identification of a crag-shell with this Turbonilla Jeffreysii which the author himself, S. Wood, declares to be uncertain. I may add besides, that there are specimens with quite as many varices as Koch and Wiegmann's Turbonilla variculosa, l. c., p. 106, pl. 3, f. 8, exhibits, and on the whole, I can not but agree with Forbes and Hanley who think several species, e. g. Ch. gracilis and pusilla of Philippi, to be separated from Ch. elegantissima without sufficient reason. I leave it open, whether this is also the case with Ch. elegantior S. Wood (Crag Moll. I. p. 81, pl. 10, f. 5, suppl. p. 61.), originally called Ch. elegantissima.

Cerithiopsis rugosa Gould.

(Otia Conchol. p. 143).

The highly typical, particular and nice Sculpture, together with size and dimensions (15 mm. in length and 4 in diameter) prove the identity of one of the Oji shells (one specimen) with the living Chinese species of Gould.

Pleurotoma tigrina Lamarck.

(Hist. nat. des anim. s. vert.—1856 Gould, U. S. Exploring Exp. of Wilke., p. 249, pl. 18, f. 311.).

A few specimens were found at Oji, belonging to the turreted, sharp-keeled form with long curved Sipho and a minor carina just above the suture.

Drillia reciproca Gould.

(Otia. Conchol. p. 135).

Long, fusiform, with 10 convex whorls, on which there are 4 or 5 transverse carinæ, the middle one of which is a little stronger and somewhat granular. The intervals are obliquely striated, the obliqueness being in different direction according to the position above or below the sinus. Sinus deep and broad, lip produced, canal short, broad and twisted; aperture only about ⅓ of the total length. The largest specimens attain nearly the length noted by Gould, 12 mm., with the same proportion in diameter, viz. ⅓ of the axis. This shell which does not agree with any other but the species of Gould to which I unite it, was frequently met with at Oji. The recent specimens were found at Oshima.

Mongelia striolata (Scacchi). Phil.

Moll. Sicil. Vol. II, p. 168, pl. 26, f. 7.—Forbes and Hanley, brit. Moll. Vol. III, p. 483, pl. 114 A, f. 1 and 2.—Jeffreys, brit. conch. v. 4, p. 376. S. Wood, Crag Moll. Suppl. p. 179 and Addendum-pl., f. 2.

Not as frequently found at Oji, as the foregoing shell; apex somewhat obtuse, canal lengthened, aperture narrow, whorls with a prominent angle near the apical side. Longitudinal ribs, about 9 or 10, also shouldered and often a little oblique, are crossed by transverse striæ. The characters do not differ in any particular from the British specimens, fossil or recent. Among all the species mentioned by Gould, only M. semiassa, Ot. conch. p. 137, might be identical; but its whorls have their elevated part nearly in the middle.

Terebra bipartita Gould.
(Otia Conchologica p. 126.).

This species was rarely found at Oji, the specimens having up to 18 mm. in length, and nearly 5 mm. in diameter. The number of longitudinal ribs is 13 to 16; in their intervals, we see very finely punctated transverse lines mentioned by Gould, one of which is stronger, and placed at ⅔ of each whorl from the lower, ⅓ from the upper or posterior suture. The specimens show very weak traces of the differences of color seen in the recent shells from Japan.

Trichotropis (Iphinoë) coronata Gould.
(Otia Conchol. p. 121.).

The very curious and elegant species, as Gould says, has been rarely found at Oji. The specimens are much smaller than those which Gould mentions from the Arctic Seas (Straits of Semiavine). For the latter are said to have little more than 6 whorls and 25 mm. in length by 18 mm. in diameter, whilst the fossil in Oji specimens with 5 whorls, have only 10 mm. in length and 6 in diameter. The dimensions, however, and the very typical form and sculpture (one strong keel on an angulated margin, above or behind which the shell is quite even and horizontal, whilst it is also smooth, but rotundated, below or anteriorly, the wide and deep umbilicus with its sharp margin, the simple lip and ovately triangulated orifice), so perfectly agree that a specific separation seems quite untenable. Moreover, the number of the whorls in the larger specimens may be diminished by resorption, as Gould's statement: anfr. 6 + etc.; seems likewise to indicate. At the utmost, the Japanese fossil form could be distinguished as a dwarfish variety.

Trochus argyrostomus Gmelin.
(Syst. Nat. Linn. ed. 13, p. 3583.—Chemnitz, conch. cab. vol. 5, pl. 165, f. 1562 & foll., and ed. nov. Trochus pl. 6, f. 1.2. Lischke, Jap. Meeres-Conch. vol, p. 96, pl. 7, f. 3-5).

Some fragmentary specimens of the obtuse conical species (with closed umbilicus) suffice to give evidence of the existence of this species (peculiar to the East-Asiatic shores and continental isles from Korea to the Phillipines) within the compass of the formation of Oji.

Tornatia exilis Dunker.
(Moll. Japan. p. 25, pl. 2, f. 14.-Lischke, Jap. Meeres-Conch. vol. p. 105.).

Very seldom at Oji, the shell is nearly cylindrical, rounded at the ends; the spire slightly elevated with mammillated—sinistral—apex. The aperture is narrow in the upper part, somewhat broader below, with a feeble fold on the columella.—These characters coincide with those which S. Wood gives for his Bulla Lajonkaireana Basterot (Crag Moll. I, p. 178, pl. 21, f. 5), rectius Bulla mammillata Philippi, Enum. Moll. Sic. v. 1, p. 222, pl. 7, f. 20, and Weinkauff, Conch. d. Mittelm. vol. 2, p. 201, Forbes and Hanley, pl. 114 C, f. 4 and 5, so that I regret very much not to have any specimens, living or fossil, at hand. The size—$\frac{1}{7}$ of an inch in the Crag specimens and 4 millim in those of Oji, with 2 in diameter—agrees also. The only difference is the surplus of diameter which is to be seen in the upper part of B. mammillata (or Lajonkaireana), and of which the specimens of Oji do not show any trace. From Wood's remarks, however, it appears that this character is not quite constant and Forbes and Hanley's figure represents another deviation from the cylindrical form, namely a reduction of the diameter in the middle of the shell. If all these characters were really variable, there would be no reason whatever to separate these 2 species.

Bulla (Cylichna) cylindracea Pennant.

(Brit. Zool. vol. IV, pl. 70, f. 85. S. Wood, Crag Moll. I, p. 175, pi. 22, f. 1.—Forbes and Hanley brit. Moll. pl. 114 B, f. 6.—Jeffreys, brit. Conch. v. 4, p. 415. Weinkauff, Conch d. mittelmeeres. v. 2, p. 194).

The cylindrical form and the perfectly hidden spire together with the dimensions and proportions (10 mm. of axis, 3.5 of diameter) show that the few bullæ found at Oji belong to B. cylindracea. As to Bulla parallela Gould, Otia Conch. p. 98, moll. of Wilke's expl. Exped. pl. 15, f. 267, it is excluded by its transverse striæ on both ends of the shell which are totally wanting in the Oji specimens.

SOLENOCONCHÆ.

Dentalium octogonum Lamarck.

(Hist. nat. d. anim. s. vest. 2d. ed. vol. V. 3, p. 701,—Sowerby, Thes. Conch. vol. V. p. 102, pl. 223, f. 9.—Lischke, Jap. Meeres-Conch vol. 2, p. 103, vol 3, p. 75. pl. 5, f. 1-3.).

The octagonal outline of the cross-section divides this species sharply from the following one, even from its ribbed varieties. I omit to discuss the question whether D. hexagonum Gould, Otia conch. p. 119. Sow. l. c f. 10, Lischke Vol. 3, p. 174, pl. 5, f. 4-7, is really a good species, though I think this is not the case. The few specimens found at Oji all belong to the typical octagonal form.

Dentalium entale Linné.

(Syst. Nat. p. 1263.—Philippi, En. Moll. Sic. Vol. II, p. 206.—S. Wood, Crag Moll. I, p. 189, pl. 20, f. 2, and Suppl. p. 92, pl. 6, f. 20, add. pl. f. 12.—Forbes and Hanley, brit. Moll. Vol. 2. p. 451, pl. 67, f. 12.—Syn. D. Tarentinum Lamarck. anim. s. vert. vol. V. p. 345, Weinkauff, Conch. d. Mittelm. v. 2, p. 416; Jeffreys, brit. Conch. v. 3, p. 195.).

The specimens of Oji, small, smooth, thin and moderately curved, can not be united with the species found living near the Japanese coast, e. g. D. octogonum.

CONCHIFERA.

Solen grandis Dunker.

(Novitates conchol. II, p. 71, pl. 24, f. 5.—Lischke, Japan. Meeres-conch vol. I, p. 141.).

Straight, with parallel margins, obliquely truncated in front and rounded behind, moderately slender (length to height 1:4 or 1:5) solens found in great number at Oji are not different from the shell which by the above mentioned Authors has been described from the Philippine islands and Nagasaki, but which also is found at Yenoshima. The hinge, having but one tooth in each valve, quite close to the anterior margin in the right and a little behind in the left valve, suffices to distinguish this true solen from species similar in appearance (S. gladiolus Gray, also S. siliqua, which is besides a little more slender), whilst the pacific species belonging to the same group are all excluded by their different outlines (e. g. Solen sicarius Gould, Otia conch. p. 74, by its greater height and curved inferior margin; S. gracilis. Gould, or Solen Gouldii Conrad in Amer. Journ. of conch. Vol. III, 1867, App. p. 28 and Lischke, Jap. Meeres-conch. v. 2, p. 123, and also S. strictus Gould and S. corneus Lamck. by their much smaller height).

It is to be added, however, that S. sicarius, according to the figure given in the Atlas of Moll. &c. of Wilke's Exped. pl. 33, f. 501, may be less different than the diagnosis seems to indicate.

Saxicava arctica Linné (Mya).

(Syst. Nat. ed. 12, p. 1113, Gmelin, Linn. syst. nat. ed. 13, p. 3226.—Phil. Enum. Moll. Sic. vol. 2. p. 19.—Forbes and Hanley, brit. Moll. I. p. 141, pl. 6, f. 4-6 and pl. F, 6.—Jeffreys, brit. conch. v. 3, p. 81, as S. rugosa var. arctica. S. Wood, Crag moll. II. p. 287, pl. 29, f. 4.—Weinkauff, Conch. des Mittelm, vol. I, p. 20.—Lischke, Japan. Meeres-Conch, v. 1, p. 134, v. 2, p. 122 & 165. v. 3, p. 100.).

The variable, world-wide species, which is also very often found in Tertiary deposits, occurs abundantly at Oji. It is mostly small, but in a few instances reaches 18 mm. in length and 11 in height.

Panopaea generosa Gould.

(Otia conch. p. 165 and Atlas of Moll. & shells of Wilke's Expl. Exp. pl. 34, f. 507.).

Exactly corresponding to the description and figure of Gould, the specimens of Oji are determined accordingly. They are not very numerous and not much above 100 mm. in length, and 65 in height, umbones being at 45 mm. distance from the anterior margin. It is not the place here to discuss whether and how far Gould's species deserves to be kept; from Panopæa Faujasii M. de la Groye (Ann. du Mus. vol 9, p. 131. pl. 12, 1807; Basterot. Foss. de Bordeaux, p. 95; Phil., En. Moll. Sic. vol. 1. p. 7, pl. 2, s. 3.; Goldfuss, Petr. Germ. vol. 2, p. 274, pl. 159, f. 1; Sow, Min. Conch. pl. 611, f. 3 & 4; Weinkauff, Conch. d. Mittelm. vol. 1. p. 22 as P. glycimeris Born; Wood, Crag Moll. II, p. 283, pl. 27, f. 1), Lamarck's Panopaea Aldrovandi, I do not find any constant difference. For straightness of the upper margin and nearly equal broadness of the posterior and anterior part of the shell are also found among the specimens of P. Faujasii, and even the direction of the lines of growth (and of the irregular, somewhat coarse folds or concentrical ribs which in both species are parallel to these lines of growth) are sometimes nearly parallel to the upper part of the shell in both the P. generosa and Faujasii, and the deviations from that direction (in P. Faujasii, as e. g. Goldfuss' very good figure exhibits, more convergent to the posterior side of the upper margin; in P. generosa, as Gould's figure shows, divergent from it) seem neither to become very great, nor to be always of the same nature. The hinge and the pallial sinus do not exhibit any peculiar characters.

The shell is found recent in the northern part of the Pacific, and if the identification with P. Faujasii is tenable, in the Mediterranean and near the Atlantic coasts of Spain and Portugal. The boreal form of the Atlantic Sea is widely different, and even supposed to belong to another genus. The Yesso shell described by Gould as P. fragilis and identified with P. Japonica Adams by Lischke (Japan. Meeres Conch. III, p. 104) is different in size (2 by 1.5 inches instead of 6 by 4), has a fissure of the upper margin near the base of the tooth and a very thin shell.

Lyonsia (Pandorina) flabellata Gould.
(Otia Conch. p. 162.).

Two very small specimens are found at Oji, not larger than 1 and 3 millim., but in all characters (ratio of length to height about 17 : 10, thickness very slight, rounded anterior part and much truncated, obliquely and feebly folded hind part, beaks at $\frac{1}{3}$ of length from the anterior margin, straight upper margin, very feeble hinge and nacreous interior) perfectly resembling this Arctic species of the Pacific Ocean. I feel obliged to mention them in spite of their scarcity and of the minuteness of the specimens of a form attaining much larger dimensions, as they seem to be not unimportant as to the character of the fauna.

Myadora fluctuosa Gould.
(Otia conchol. p. 161.).

To Gould's diagnosis (small, thin, concentrically striated or rather folded, nearly equilateral shell, posteriorly a little smaller, triangular with somewhat truncated end, right valve convex, length to height as 8 to 7) the few specimens found at Oji give some additional points. The largest specimen of a right valve has 15 millim. in length and 13 millim. in height, nearly the double size of

Gould's specimen which was dredged at Kagoshima. Among the specimens there is one left valve, which Gould has not, quite flat and a little smaller, but corresponding in shape to the right valve. The concentrical undulations are spread over nearly the entire surface in most of the Oji specimens; but one of them exhibits them only in the middle part of the surface. We may therefore assume the difference of sculpture mentioned by Gould (undulis concentricis circ. 20 ad marginem haud protractis ornata) to be an individual deficiency which does not exclude our specimens from the above mentioned species.

Lutraria Nuttalli Conrad. Pl. IV, f. 16.

(Journal of Acad. Nat. Sc. Philad. vol. 7, 1837, p. 235 pl. 18. f. 1.—Lischke, Japan. Meeres-Conch. v. 1, p. 136.—Non Mactra Nuttalli Reeve, Conch. Ic. Mactra, pl. 21, f. 125.—Syn. L. Maxima Middendorf, Beitraege zu einer Malacozool. Rossica, vol. 3, p. 66, pl. 19, f. 1-4, 1849; and Reeve, Conch. Icon. Lutraria, pl. 5, f. 18, and Mactra, pl. 1, f. 4; also Adams, Genera etc. vol. 2, p. 381, pl. 101, f. 1., Chenu, Manual, vol. II, p. 59, f. 243. Syn. also L. capax Gould, Wilkes Expl. Exp. Moll. pl. 34, f. 508 and Otia Conch. p. 76 and 245.).

In denominating this important species found in tolerably great number and large specimens at Oji (reaching 130 millim. in length, 90 in height and 62 in thickness), I follow Lischke l. c. The name L. maxima, according to his statements, l. c. p. 138, is duly to be applied to another shell, L. maxima Jonas—also a Japanese and Chinese shell of nearly the same length, but much smaller height and thickness—and therefore Gould's denomination ought to be accepted if not the same shell had been already described and figured by Conrad.—The hinge—hinge-tooth broad, with appendix and plicated, narrow lateral teeth—is well preserved and quite typical, the shell covered with concentrical striæ and moderately thick. The large umbones, the large, tongue-shaped pallial sinus, the anterior rounding and posterior truncation and oblique folding are all present.

Mactra veneriformis Deshayes. Pl. IV, f. 17.

(Proc. Zool. S. oc. 1853, p. 15.—Reeve Icon. Conch. Mactra, pl. I, f. 2.—Lischke, Japan. Meeres Conch. v. 1, p. 133, v. 2, p. 121. pl. 9, f. 7 and 8).

This species, common in the Tokio-Bay, has been found at Oji, but less frequently than in other localities of the pliocene formation, e. g. Takigashira Mura. The specimens, rather oblique, obtusely carinated and moderately thick, agree perfectly with the living ones.

Mactra Sachalinensis Schrenck.

(Moll. d. Amurlandes u. d. Nord-Japan. Meeres, p. 515, pl. 23, f. 3-7.—Lischke, Jap. Meeres-Conch, v. 1, p. 132.—Syn. M. Lüdorfii Dkr., Novit. Conch. II, p. 60, pl. 20, f. a-c).

The shell which occurs frequently near the coasts of Sachalin and Yesso, has an elongated, nearly equilateral outline and a nearly straight upper margin. The proportion of length and height is given as 100 to 75 in the elongated varieties. A great many small shells agree perfectly in outline with the latter, and moreover show a perfect identity of the hinge with its rather straight line and its two duplicated lateral teeth. I omit the discussion whether M. spectabilis Lischke (l. c. v. 2. p. 120, pl. 11, f. 1 and 2) whose height is said to be about 0.79 of the length, and whose hinge is exactly the same, is not merely a very large variety of M. Sachalinensis.

Tellina Yeddoënsis Lischke.
(Japan. Meeres-Conch. v. 3, p. 92, t. 9, f. 1-3.).

From all the other small Tellinæ this species, somewhat inequilateral, shorter and a little pointed behind, with fold, with hinge-teeth and lateral teeth in the right valve, is sufficiently distinguished by the last character. (Cf. Lischke.) It is not very frequent at Oji.

Tellina nitidula Dunker.
(Malakozool. Bl. Vol. 6, p. 236, Moll. Japon. p. 27, pl. 3, f. 14.—Lischke, Japan. Meeres-Conch. v. 1, p. 129, v. 2, p. 113, pl. 10, f. 10 and 11).

This species, which is also not very abundantly found at Oji, seems to be separated into many species by Martens, Lischke &c. without sufficient reason, and really to be somewhat variable in outline and proportions. The absence of posterior lateral teeth distinguishes it from the foregoing, the outline and the presence of an anterior (small) lateral tooth in the right valve from the following species.

Tellina nasuta Conrad. Pl. IV, f. 18.
(Journal of Acad. Nat. Sc. Philad. Vol. 7, pt. 2d, 1837, p. 238.—Sowerby, Thes. Conch., Vol. 1, p. 314, pl. 64. f. 224.—Reeve, Icon. Conch. Tellina, pl. 9, f. 40.—Lischke, Jap. Meeres-Conch. v. 2, p. 115, pl. 10, f. 15-17.).

There being no doubt left about the majority of Tellinæ found at Oji belonging to this rather inequilateral, strongly folded, posteriorly short, pointed and arcuated species, I omit a further discussion on it and on its synonymy, stating only that it belongs to the most frequent shells of that locality and constitutes a considerable portion of the shell-layer.

Tapes rigidus Gould. Pl. V, f. 19.
(Otia Conch. p. 85.—Moll. of Wilke's exploring Exp. pl. 37, f. 538.).

Gould's diagnosis says: shell solid, transverse, ovate and ventricose, inequilateral, covered with concentrical laminated lines and radiating broad striæ, both of which together leave, in the anterior part of the shell, only deep points, whilst behind the intervals are short perpendicular lines; umbones high, touching one another, lunulæ broad; anterior side narrower and rounded, posterior one broad and obliquely truncated; lower margin crenulated and upper margin not much convex; 2 bifid hinge-teeth in the right valve, one bifid tooth in the left valve. This and the figure leaves no doubt about the determination of this species, which was tolerably frequent at Oji, but mostly fractured.

The largest specimens have 70 mm. in length and 60 in height.—The genus is denominated according to Gould's statement in his Index (Otia Conch. p. 256) in spite of the crenulated margin, because all the other characters agree with those of Tapes. The species has also been found living at Hakodate.

Saxidomus purpuratus. Sowerby. Pl. V, f. 20.

(Thes. Conch. vol. 2, p. 692, pl. 150, f. 124 and 125.—Deshayes, Catal. of conchifera of Brit. Mus. p. 188.—Adams, Ann. Mag. Nat. Hist. 1869, vol. 3, p. 235.—Lischke, Japan. Meeres-Conch. v. 1, p. 127, t. 9. f. 4 & 5.—Syn. S. Nuttalli Schrenck, Nordjapan. Moll, p. 253, and S. giganteus Martens, preuss. Exped. n. Ost-Asien, Zool. vol. 1, p. 140.).

As Lischke undoubtedly is right in identifying this species with the figure and description given by Sowerby, I follow him in omitting a comparison with Gould's species from the Pacific coast of America, though it is quite possible that one—if not more—of the latter are identical with the shell which has been described from Japan, Tokio as well as Hakodate, and which most likely occurs in many more places of the Japanese coasts. Lischke's supposition, Kurachee to be in fact a Japanese, not an Indian locality, seems to be confirmed by similar names occurring in Japan. The specimens found not unfrequently and of large size (105 mm. by 80 mm.) at Oji, exhibit the posterior bifid tooth of the right valve and the deep pallial sinus, which seem to indicate that Saxidomus is more akin to Tapes than to Venus proper; the concentrical striæ are numerous and sharp, the posterior side is long, very obtusely carinated and more rounded than truncated. The inferior margin is smooth.

Venus (*Mercenaria*) *Stimpsoni* Gould. Pl. V, f. 21.

(Otia Conch. p. 169).

This Hakodate species, which I could compare directly with authentical specimens from that locality, has been found only once in a complete and large specimen at Oji. The oblique shell with the acute umbones placed near the anterior end, deep lunula, convex dorsal margin, pointed posterior end, with broad hinge, shallow pallial sinus and numerous concentrical laminæ, measures 97 by 78 millim. (Recent specimens reach 105 by 87 mm.). Smaller specimens and fragments have been found in tolerably large number; they measure mostly about 15 by 12.5 millim. and have the shape of the larger; the umbones are placed at 4.6 millim. from the anterior end, the surface is covered with foliaceous concentrical ribs; the intervals are broad and longitudinally striated. The marginal crenulation is always sharp and fine.

Dosinia exoleta Linné. Pl. VI, f. 22.

(Syst. nat. ed. XII, p. 434, as Venus exoleta.—Chemnitz, Conch. Cab. vol. 6, p. 48, pl. 38, f. 104, do.—Gmelin, Syst. nat. Linn. ed. XIII, p. 3284, do.—Montagne, test. brit. p. 116, do.—Lamarck, hist. nat. pp. vol. 5, p. 512, and id. second. ed. by Deshayes, vol. 6, p. 314, as Cytherea.—Philippi, Enum. Moll. Sic. vol. 2, p. 32, and abbild. I, p. 171, do.—Reeve, Conch. Ic. Artemis, pl. 5, f. 29—Forbes and Hanley, Brit. Moll. vol. 1, p. 428, pl. 23, f. 3, 4.—Sowerby, Thes. Conch. p. 658, pl. 1 & 1, f. 12-14.—Jeffreys, brit. Conch. vol. II, p. 327, as Venus.—Weinkauff, Conch. d. Mittelm. vol. 1, p. 120.—Goldfuss, Petref. German. vol. 2, p. 241, pl. 149, f. 18, as Cytherea.—Hoernes, Foss. Moll. des Wiener Beckens, vol. 2, p. 143, f. 16, f. 2,—Syn. D. lentiformis (Venus) Sowerby, Min. Conch. pl. 203 and Wood, Crag Moll. II, p. 215, pl. 20, f. 7. Syn. also D. Japonica Reeve, Conch. Icon. Artemis, pl. 3, f. 17, Sowerby Thes. vol. 2, p. 669, pl. 143, f. 60, Roemer, Dosinia, p. 60, pl. 11, f. 4, Lischke, Japan. Meeres-Conch. v. 1, p. 127, v. 3, p. 88, and Morse, Shell-mound of Omori, p. 28, pl. 18, f. 7. Syn. also Dosinia Troscheli Lischke, Japan. Meeres-Conch. III, p. 89, pl. 8, f. 1-3).

The most minute details of the hinge being exactly the same, there can be no doubt about the Dosiniae, which I got from Oji in an unexpectedly rich supply and which were indeed the most common shells of this locality, belonging to the same species as Dosinia exoleta L., from which also D. lentiformis was quite unnecessarily separated. Outline and area, as well as pallial sinus, exhibit, in the Oji-specimens, all the variations indicated under all the above quoted names and by any of the mentioned authors. Especially the character of the stronger demarcation of the area, supposed to be typical for D. Troscheli, passes so gradually into the common form, and is not at all constantly connected with any shape of the pallial sinus or of the outline, or even of the coloring, that in fact—as I convinced myself in examining the Tokio collections—a great many of the Japanese specimens could not be strictly assigned to either of the forms.

Indeed the shell varies much, and as the large number of specimens from one locality and formation, viz. Oji, demonstrates, this variability can not be explained as a stage of evolution, or as a local modification. We must accept it as a property of the species, which, on the other hand, seems to be well distinguished from the species of the same genus, e. g. D. lincta Pulteney, close as this form is allied, or D. (Artemis) lambata Gould in Otia Conch. p. 84 and Atlas of Wilke's Exp. pl. 37, f. 536. Dosinia exoleta L. therefore must be considered as one of the truly palaearctic forms of which indeed already a certain number has been generally admitted. We may add that the range of the variations is not essentially increased by all the other Japanese localities, fossil or recent.

Considering these variations, we must indeed reject the conclusions of Morse, who l. c. gives the average of the proportion of length to height in the recent shells as 0.939, in the shells from the mounds as 0.952. The Oji shells have a range in this respect from 1 down to .927, which may include almost any proportions observed anywhere. At least I found only some of the so called D. Troscheli going down a little below 0.92. As for the size, it is quite true that the Oji shells surpass as well the recent as the mound specimens, and not rarely have 80 mm. of diameter, or 80 of length to a little less height. But as the number of specimens measured by Morse is so very small (10 recent and 9 mound-specimens), especially when compared with the many hundreds dug out at Oji, this fact loses very much of its importance, and scarcely justifies any conclusion on a gradual diminution of the size of this species which, at first sight, it seems to support.

Indeed, an examination of the Tokio collections of recent shells gave, at its very beginning, the maximum length of recent Dosiniæ (both labelled as D. Troscheli and as D. Japonica) equal to 75-77 millim., the height being in the first case, equal to the length, viz. 75 millim. in the second 71, (ratio of height to length being about 0.92).

Cardium Californiense Deshayes.

(Revue par la Soc. Cuvier. 1839. p. 360.—Middendorff, Malacozool. Rossica, vol. 3, p. 40, pl. 15, f. 23-25.—Lischke, Japan. Meeres-Conch. v. 1, p. 144, and v. 2, p. 125.—Syn. C. blandum Gould. Otia Conch. p. 83. and Atl. Wilke's Expl. Exp. pl. 26, f. 534. Syn. also C. pseudofossile Reeve, Conch. Icon. Cardium, pl. 10, f. 52.).

The numerous ribs (often 40) are separated by narrow intervals and crossed by feeble, undulating concentrical lines; the shell is nearly equilateral and but slightly elongated. Most of the specimens of Oji have less than 17 mm. in length and 15 in height; only one is considerably larger, but broken. They are not very numerous, and do not allow any serious approach to the question about the relation of this species to C. Islandicum Linné (Syst. Nat. 12th ed. p. 1124; Gould-Binney, Rep. on Inv. of Mass. p. 139), with which Gould in the Otia declares it to be analogous, and to which it seems quite akin.

Cardium muticum Reeve.

(Conch. Icon. Cardium, pl. 6, f. 32.—Lischke, Japan. Meeres-Conch. vol. I, p. 144.—Syn. C. japonicum Dunker, Moll. Japon. p. 28, pl. 3, f. 16.).

According to Lischke, this species is not synonymous with C. papyraceum Chemn., Conch. cab. vol. 6. p. 190, pl. 18. f. 184, though Schrenck (Nord Jap. Moll. p. 517) unites them. At all events I can confirm one of the statements given by Lischke, viz. that C. muticum, a large, comparatively thin-shelled species with somewhat broad ribs and intervals, is always a little transversely elongated. The largest of the unbroken specimens (which are far from being frequent), has 75 millim. in height, and 85 in length. They are obliquely elongated behind.

The species, though not frequent at Oji, is not uninteresting as one of the species occurring in the sandstones of the north eastern coast of Japan.

Laevicardium bullatum H. and A. Adams.
(Genera of recent shells, vol. 2, p. 437. Moerch, as Cardium, Cat. Conch. Yoldi, vol. 2, p. 33.).

According to Lischke (Japan. Meeres-Conch., v. 3, p. 106), this species is not synonymous with Cardium bullatum Lamarck, and of Reeve, but to C. rugatum of these authors quoted by the former in his Histoire Naturelle pp., 2d ed, vol. 6, p. 393, and figured by the latter in the Icon. Conch., Cardium, pl. 12, f. 63. It has been given, as Lischke says, under the same name by Menschen in the Zoophylacium Gronovianum vol. 3, p. 266. no 1125, pl. 18, f. 5, and by Lischke. Without entering into this question, I mention only the few specimens, mostly broken, which were found at Oji. They are thin, subspherical, nearly circular in outline, not much elongated behind. The surface is very delicately radiated and concentrically striated. Fulvia centifilosa Carpenter, perhaps only a variety of Cardium (Lævicardium) modestum, differs by having weaker radii behind, whilst our species does not show any difference between both ends of the shell.

Lasaea rubra Montague.
(Test. brit. p. 83, pl. 27, f. 4, as Cardium.—Forbes and Hanley, Brit. Moll. vol. 1, p. 94, pl. 36, f. 5-7, as Poronia rubra, and pl. O, f. 3.—Jeffreys, brit. Conch. vol. 2, p. 219.—Woodward, Manual of Conch. pl. 19, f. 13, as Kellia, subgenus Poronia.—Weinkauff Conch. d. Mittelm. vol. 1, p. 177, as Poronia.—Wood, Crag-Moll. II, p. 125, pl. 11, f. 10.—Lischke, Japan Meeres-Conch. vol. II, p. 137.).

The small species, rounded, not quite equilateral, a little elongated behind, covered with strong concentrical striæ and a very fine and minute radial striation and with the typical hinge of the genus, has been already identified by Lischke. The diagnoses of the numerous species of this genus given by Gould are all different. A few specimens only were found at Oji, but at Shinagawa the species was met with in a larger number of specimens.

Kellia suborbicularis Montagne.
(Test. brit. p. 38 and 564, as Mya.—Forbes and Hanley, brit. Moll., vol. 2, p. 87, pl. 18, f. 9.—Jeffreys, brit. Conch. vol. 2, p. 225.—Wood, Crag Moll. II, p. 119, pl. 12, f. 8.—Weinkauff, Conch. d. Mittelm. vol. 1, p. 174.).

The same may be said about the distribution of the very smooth, ventricose shell which also exhibits the typical hinge of its genus. A separation from the British and Mediterranean—recent and fossil—specimens is the more to be rejected as the shell is known to be variable, and as the fossil Japanese specimens do not go beyond the limits pointed out by the above mentioned authors, either in their form or in their size.

Lucina borealis Linné. Pl. VI, f. 24.

(Syst. nat. ed. 73, p. 1184, as Venus.—Forbes and Hanley, brit. Moll. vol. II, p. 46, pl. 35, f. 5.—Jeffreys, brit. Conch. vol. II, p. 242.—Hoernes, Foss. Moll. des Wiener Beckens, vol. II, p. 299, pl. 33, f. 4.—Wood, Crag Moll. II, p. 139, pl. 12, f. 1.—Weinkauff's Conch. d. Mittelm vol. 1, p. 162).

The most minute examination of form, outline, internal and external sculpture and hinge has not revealed the slightest difference between a Lucina, found very often, though mostly in small specimens at Oji, and the fossil and recent European Lucina borealis. The strong concentrical striæ, the deep lunula, the flat, circular shape, the slight internal ridge before the posterior muscular impression (almost, though not quite constant), the oblique central furrow of the inside:—all these, and in fact, all the other characters perfectly agree.

The largest specimens of Oji are 25 mm. in length and 23 mm. in height.

Diplodonta trigonula Bronn. Pl. VI, f. 25.

(Ital. Tert. Geb. p. 96; pl. 3, f. 2.—Philippi, Enum. Moll. Sic. vol. II. p. 24.—Hoernes. Foss. Moll. des Wiener Beckens, vol. II, p. 218, pl. 32, f. 4.—Weinkauff Conch. des Mittelmeeres, vol. I, p. 158.—Syn. D. apicalis Phil., l. c. vol. I, p. 31, pl. 4, f. 6, and vol. 2, p. 24, younger form. Syn. also D. astartea Nyst, Coqu. foss. belg. p. 121, pl. 6, f. 4. and Wood, Crag Mollusca II, p. 146, pl. 82, f. 2.).

The obliqueness, the triangular form with obliquely descending hinge-margin, and with posterior elongation. together with the simple concentrical lines and folds of the surface, prove the identity of the above-quoted species and of one of the shells found frequently in the layer of Oji. The hinge exhibits some difference from D. orbella Gould (Otia Conch. p. 212, Lischke, v. 2, p. 133) as there is a posterior lateral tooth, though somewhat indistinct (except at the end of the area, where it becomes more distinctly visible); but this species is still more decidedly excluded by its equilateral, rounded and globose form. Our specimens reach 20 mm. in length, 25 in height and 12 in thickness. The umbones are at $\frac{1}{3}$ to $\frac{2}{5}$ of the length from the anterior end.

Arca inflata Reeve.

(Conch. Icon. Arca, pl. 5, f. 30, Lischke, Japan. Meeres-Conch. vol. I, p. 146, and vol. II. p. 144. Morse, shell-mound of Omori, p. 26, pl. 18, f. 5.—Syn. II. Broughtoni Schrenck, Moll. des Amerlandes u. des Nord-Jap. Meeres. p. 578, pl. 24, f. 1-3.).

This shell is found frequently at Oji, 90 mm. in length, 74 in height and 60 in thickness, with 38 to 45 ribs. The posterior part is a little narrower, the lower margin, being bent upwards, and obtusely pointed. As for the synonyms, I refer to Lischke.

The shell being very common at Tokio, it is indeed striking that it is so rarely met with at Omori.

The specimens described by Morse as having an unusually broad hinge area are possibly exceptionally developed; the Oji-specimens do not differ from the living.

Arca subcrenata Lischke.

(Japan. Meeres-Conch. vol. I, p. 146, pl. 9, f. 1–3, and vol. II, p. 144.—Morse, shell-mound of Omori, p. 25.).

Of this species (differing from the foregoing by a much smaller number of ribs, viz. 30 to 33, instead of about 42, by their crenulation and by the characters of the sub-genus Scapharca), some small specimens have been found at Oji which perfectly agree with Lischke's diagnosis and figure and with recent specimens. They are neither numerous nor large enough to allow any remarks about deviations from the Omori or recent form, like those described by Morse.

Pectunculus glycimeris Linné. Pl. VI; f. 26.

(Syst. nat. ed. 12, p. 1143, as Arca —Forbes and Hanley, brit. Moll. vol. 2, p. 245, pl. 46. f. 4-7.—Jeffreys, brit. Conch. vol. 2, p. 166.—Weinkauff. Conch. d. Mittelm. vol. I, p. 183.—Wood, Crag Moll. II, p. 66, pl. 9, f. 1, and second Suppl. p. 43, pl. 6, f. 5.—Schrenck, Moll. des Amurlandes u. Nord-Japans, p. 580.—Syn. P. nummarius Brocchi, conch. foss. subap. p. 483, pl. 2. f. 8, auctore S. Wood.—Syn. also P. pilosus? Linné, Lamarck, hist. nat. vol. 6, 1, p. 49, No. 2, Philippi. En. Conch. Sic. vol. 2, p. 44, and vol. I, p. 62.—Syn. also T. variabilis Nyst. Coq. foss. belg. Vol. 2, p. 2 and 9, pl. 20, f. 1.—Syn. also P. albo-lineatus Lischke. Japan. Meeres-Conch. vol. III, p. 198, pl. 9, f. 11 and 12.).

Authors generally unite the two Linnæan species, whilst Weinkauff gives like Born the name P. pilosus to the P. bimaculatus of Poli. He also excludes the P. insubricus Brocchi, which is united to P. glycimeris by some, and gives that name to the species better known under the Lamarckian name of P. violascens or violacescens.—The best list of synonyms is generally said to be that of S. Wood. l. c., to which I add only the P. albolineatus of Lischke, as I could not find any constant differences between the Japanese and European specimens. At all events, the punctures on which Lischke lays some stress are to be seen in most of the Oji specimens, and, at the same time, they do not differ from what is seen in many of the European shells of this species. As for the coloring, it is known to be variable in P. glycimeris, and the white radiating lines can scarcely be of any importance in a shell which has radial ribs.

The specimens found at Oji are—like all the fossil specimens of the other localities to be mentioned—mostly small, seldom exceeding 50 mm. in length, 48 in height, and 30 in thickness. They belong to the transverse or circular variety, not to the elongated one. Their number is, though decidedly inferior to the

Solen, Mactra sachalinensis, Tellina nasuta, to the Lucina and Diplodonta, and above all to the Dosiniæ, yet by no means small.

Nucula Cobboldiæ Sowerby Pl. VI. f. 28 and 28 a.

(Min. Conch. pl. 180, f. 2. 1818.—Lyell, Elem. of Geol. p. 299, f. 113, in the 2nd ed. 1841.—Wood Crag Moll. II, p. 82, pl. 10, f. 9, and suppl. p. III, pl. 10, f. 2.—Woodward Manual of Moll. pl. 17, f. 18.—Syn. N. mirabilis Hinds. Adams and Reeve.—Syn. also N. insignis Gould, Otia Conch, p. 175. Syn. also N. Lyalli Bell, Ann. and Mag. Nat. Hist, 1871, ? cett.).

There can be no doubt about the fact, that the Japanese Nuculæ of the type of N. Cobboldiæ (genus Acila) have only been separated in consequence of so few specimens having been examined. The localities in which this shell is found fossil, supplying to a great extent this want, the identification, so much doubted and objected to by the author of the highly valuable monograph on the Crag-Mollusca, becomes unavoidable. The specimens found at Oji, tolerably numerous and well preserved, answer, on the whole, to Gould's diagnosis and description as well as to the figure given of N. mirabilis. According to Gould himself, N. insignis is almost identical with this shell, and it differs only in two trifling points, viz., the angle formed by the inferior margin with the smaller, straight side margin (an angle very variable in the different specimens), and in the angular markings at the extremities, which appear in Hind's figure, and which sometimes, but not often, are also seen in the Oji specimens. On the other hand, there is no difference whatever from the true N. Cobboldiæ. Especially the larger specimens found not at Oji, but at Shinagawa, Kanagawa, Yokohama and in the province of Mino—specimens to which however some of the Oji specimens approximate—are perfectly similar to the larger specimens of N. Cobboldiæ. The posterior part (Gould's anterior one) is elongated, rounded at the extremity; the anterior one (Gould's posterior side) is truncated, often concave, sometimes provided with a prominent rounded keel; and sometimes next to this keel, there is in some specimens even a slight furrow which makes the angle appear still sharper. As for the sculpture, I dare say that the zigzag lines, diverging from the central axis of the side-face, always cover either the whole surface or at least the greater part of it. In this respect, indeed an important objection to the identification would be the remark of Wood (in his supplement) about a smooth belt in very large Crag-specimens, if I had not succeeded in finding it also in some of the Kanagawa and Shinagawa specimens. I figure it, fragmentary as the specimen is, and may add that indications of this belt are not unfrequent in other specimens. For instance one more of the Mino specimens has a distinct belt on the anterior and posterior side (especially the latter) and would show it most likely entirely, if the central portion was not fractured. Another Kanagawa specimen has a rather broad belt (2 mm.) behind, but it is smaller in the anterior part of the shell. This specimen has only 27 mm. in length and 20 in height (like the one which is figured); the other one which is belted has 37 millim. in length and 28 in height. British specimens, of 21 and 25 miliim. in length, with 17 and 18 millim. in height, have a smooth belt; others again do not show it. At Oji, the shells are always below 20 mm. in length, the largest I have before me measuring 17.5 millim. in length, and 13 in height. It is the only one which has a slight trace of a belt. The proportion of length to height changes from $\frac{3}{4}$ to $\frac{4}{5}$. The number of teeth is much more variable than I find it noted. It sometimes goes down to 8 anterior teeth (posterior according to Gould) and 16 posterior (Gould's anterior). The shells quoted by Wood, Crag Moll. II, p. 83, in order to prove the wide vertical and topographical range of the group Acila, viz. a recent species dredged off the Cape of Good Hope, and the cretaceous N. bivirgata and ornatissima, have—as Wood himself says—no specific relationship with our shell. Their existence, therefore, cannot have any value in deciding the question under consideration. As to N. Lyalli, the identity of Bell's specimen with N. Cobboldiæ is affirmed by Wood himself in the supplement, p. 112. The Pacific shell originally called so must, therefore, be very much like our species. The characters added by Wood (ib. p. 115) as belonging to the Pacific shells are indeed not to be seen in the recent Hakodate specimens, nor in the fossils I had before me except in the very large and fullgrown fossil specimens mentioned above.

N. Cobboldiæ is decidedly quaternary in England, as Wood remarks in his supplement, and did not die out there before the latter part of the glacial period.

Leda confusa Hanley.

(Sowerby, Thes. vol. 3, p. 119, pl. 228, f. 85.—Reeve Conch. Icon. Laeda, pl. 5, f. 24, bis.—Lischke, Jap. Meeres-Conch. vol. III, p. 109.—Syn. Nucula pella. Sow. Conch. ill. Nucula, f. 4, non. cett.).

The shell, posteriorly narrow and a little shorter then in the rounded anterior portion, concentrically striated, is very rarely found at Oji.

Yoldia arctica Broderip. Pl. VI, f. 29.

(Broderip and Sowerby Zool. Journal No. 15, p. 359, pl. 15, f. 1.—Middendorf, Mém. de l'Acad. de Petersb., p. 544.—Syn. Nucula lanceolata Sow, non Lamarck; Wood Crag Moll. II. p. 88, pl. 10, f. 16, and suppl. p. 115; and sowerby, 1817, Min. Conch. pl. 180, f. 1.).

Without entering upon the question of the correctness of the denomination, I reject the name differently used by Lamarck and Wood and give the usual name to the shell, a few specimens of which, reaching 34 mm. in length and 18 in height, were found at Oji. These specimens, widely differing from all the Pacific species mentioned by Gould, Stimpson etc., have the oblique undulating sculpture and transversely elongated, posteriorly shortened and narrow, anteriorly elongated and rounded form belonging to the species. All the other characters (smoothness of the part next to the posterior upper margin, solidity of hinge etc.) are present.

Pecten (Pseudamussium) plica Linné. Pl. VII, f. 30.
(Syst. nat. ed. 12, p. 1145.—Sowerby, Thes. vol. I, p. 65, pl. 20, f. 237—239.—Reeve. Conch. Icon. Pecten, pl. 3, f. 16.—Lischke. Japan. Meeres-Conch. vol. 2, p. 160, vol. 3, p. 113.).

This radially ribbed and strongly folded species is the most frequent of all the Pectines of Oji.

Pecten (Vola) laqueatus Sowerby. Pl. VII, f. 31 and 31 a.
(Thesaurus Conch. vol. I, p. 46, pl. 15, f. 101.—Reeve, Conch. Icon. Pecten, pl. 30, f. 135.—Lischke, Japan. Meeres-Conch. vol. 1, p. 167, vol. 2, p. 157, pl. 12, f. 1 and 2.).

Nearly circular with about 13 broad and rectangular ribs, broader than the intervals in the convex valve, smaller in the flat one, with concentrical striæ, this shell—thinner than the allied species generally are—is found rarely at Oji. More numerous and a little larger specimens will be mentioned from Shinagawa.

Pecten (Vola) Yessoënsis Jay.
(Report. on the shells coll. by Perry's Exped., p. 293, pl. 4, f. 1 and 2, pl. 3, f. 3 and 4.—Dunker, Novit. Conch. p. 61, pl. 21.—Schrenck, Moll. des Amurlandes u. nordjapan. Meeres. p. 484, pl. 20, f. 1-4.—Lischke, Japan Meeres-Conch. vol. 1, p. 165, pl. 10, f. 384, vol. 2, p. 157, pl. 13.).

Many rounded and not very broad radiating ribs cover the surface of the shell. They are not radially striated, but show only the lines of growth. The shagreen-like epidermis of the flat valve, seen in all the recent specimens from Hakodate, are not preserved in the fossil specimens, which do not show neither the overlapping of the concave valve, and, on the whole, are not at all frequent. Especially from Oji I have got only fragments, sufficient however to give doubtless evidence of the presence of this species in the tertiary layers of the environs of Tokio.

Ostrea gigas Thunberg.
(Kong. Vetenskaps akademiens nya handlingar, vol. 14, 1793, p. 140, pl. 6, f. 1-5.—Lischke Japan. Meeres-Conch. vol. 1, p. 174, vol. 2, pl. 14, f. 182. p. 160, vol. 3 p. 114.—Syn. O. Laperousii Schrenck, Nordjap. Moll. p. 475, pl. 19, f. 1-6, auct. Lischke).

Like Lischke, I confine myself to identify the shell which in the fossil state has been met with at Oji and in most of the localities to be mentioned in the following chapters somewhat more rarely than it is now found. It is eminently elongated, has a strong shell, somewhat laminated, pointed in the lower valve, the upper being shorter and flat.

Anomia patelliformis Linné. Pl. VII, f. 32.

(Syst. Nat. 12th ed. p. 1151.—Forbes and Hanley, brit. Moll. pl. 56, f. 5 and 6.—Jeffreys, brit. Conch. Vol. II, p. 34.—Weinkauff Conch. d. Mittelmeeres, vol. 1, p. 282.—S. Wood, Crag-Moll. II, p. 10, pl. I, f. 4.—Syn. A. striata Lovén, Forbes and Hanley, brit. Moll. pl. 55, f. 1 and 6, and pl. 53 f. 6, vol. 2, p. 336.—Lovén, Ind. Moll. Scand. p. 29.—Wood, Crag-Moll. II, p. 11, pl. 2, f. 3, 1st suppl. p. 100, 2nd suppl. p. 41. pl. 6, f. 3.).

The properties of Anomiæ found in the tertiary shell-layers leave no doubt about the determination. The thin shells, covered with irregular, undulating, small round ribs and undulating striæ, exhibit sometimes traces of reddish or purple color. The muscular scars (3 of the upper valve, sometimes confluent, the lowest being smaller snd placed to the left side of the spectator), exactly correspond to the figures given by Forbes and Hanley, and S. Wood. I think it very probable that the shells mentioned by Lischke (Japan. Meeres-Conch. vol. 1, p. 80) as different from his A? laqueata, to which I may add specimens abundantly found at Yokohama, also belong to this species which is known from many places of the Pacific Coast. It was very rare, however, at Oji.—

As the results to be derived from this list of mollusca may better be given after it has been completed by the addition of the species from other localities, I pass to the next places of exposure.

CHAPTER V.

THE TERTIARY DEPOSITS WITHIN THE PRECINCTS OF TOKIO.

One locality alluded to in the second chapter, situated at the foot of the ridges between Oji and that part of Tokio which is called Uyeno, and containing only such tertiary fossils as have been redeposited in alluvial layers, has furnished a certain number of specimens of shells mentioned above (Tellina nasuta Conr., Dosinia exoleta L., Ostrea gigas Thunb., Saxidomus purpuratus Sow., Arca inflata Reeve), but no species which is not contained in the Oji layers, and therefore it may be dismissed here. Another exposure shown to me and situated in the north-western part of Tokio, and said to have formerly exhibited the shell-layer, does not show any trace of it now, deep though the cutting of the road is which in this place leads down from the plateau to one of the tracts of low ground. Similar is the case of the well-diggings often mentioned and almost always reaching the tertiary shell-bed. The only locality therefore, which remains to be mentioned in the northern parts of Tokio, is Surugadai.

SURUGADAI.

Between Surugadai and Seido, at a short distance from Nihon-Bashi to the north, there is a very deep cutting through which the canal of Kandagawa goes. This cutting and the canal itself separate Surugadai from the rest of the diluvial plateau and isolate this projecting part of it. The entire hill of Surugadai is said by some authors to have been the result of the construction of the canal which took place in the 17th century. This assumption is improbable on account of the great extent and height of the hill, which exactly equals the plateau on the other side of the canal; and it becomes entirely untenable after an examination of the steep slopes of the canal-cutting. For there we see native rocks outcropping on the banks of either side which perfectly correspond to one another. The deeper layers are uncomformably covered by horizontal strata rich in pebbles, but partly clayish, which are themselves covered by the upper diluvial loam. The thickness of both of these parts of the diluvial formation and their distance from the upper margin is, of course, by no means uniform; the following measurement, made in that part of the northern slope where the lower strata are richest in fossil shells, may be taken as an average. The soil, however, has been removed there to some extent near the upper margin, a road being led over the height and deepened under the original surface. Below the level of the road, I found 5 meters of the upper diluvial loam; 4 meters of lower diluvium with pebble-strata; 5 meters of clay containing shells. Under this part of the slope, a less steep portion it filled up with detritus and soil broken off from the upper parts, measuring (vertically) 2 meters. Below the surface of the water, a boring was made which gave the same clay for at least 2 meters more. The strike and dip of the strata could not be measured exactly, but they seem to have a very slight dip to SE. They are clayish, but impure, and resemble very much the Oji strata. An accumulation of shells in one layer, like that of Oji, however, is not observed, and the clay contains some shells or fragments almost in every part which is exposed. I can only notice a maximum about the middle of the abovementioned 5 meters. The number of the shells collected would have been large enough, if they had not been mostly broken.

Great care was to be taken not to mix recent shells—or shells imbedded in the embankment at the period of its construction, like those mentioned by Morse in his Memoir on Omori, p. 35—with the fossils, and no specimen was collected or noted which was not dug out by myself or in my presence. Thus I obtained the following Oji species:

Nassa japonica Lischke.
Columbella scripta L.
Natica Lamarckiana Recluz.
Cerithiopsis rugosa Gld.
Dentalium entale L.
Solen grandis Dkr.
Saxicava arctica L.
Panopaea generosa Gld.
Mactra veneriformis Desh.
Mactra Sachalinensis Schrenck.
Tellina nasuta Conr.
Tellina Yeddoënsis Lischke.
Dosinia exoleta L.
Cardium Californiense Desh.
Laevicardium bullatum Ad.
Arca inflata Reeve.
Arca subcrenata Lischke.
Ostrea gigas Thunb.
Anomia patelliformis L.

To those 19 species, the following 6 are to be added which have not been found at Oji.

Rapana bezoar Linné. Pl. II. fig. 2.

(Syst. nat. ed. 12, p. 1204, as Buccinum.—Lamarck, Hist. nat. &c. second ed. v. 9, p. 514, as Pyrula.—Reeve, Conch. Icon. Pyrula, pl. 4, f. 15.6.—Lischke, Japan. Meeres-Conch. v. 1, p. 51.—Morse, Shell-mound of Omori. p. 34).

Lischke describes quite correctly the Tokio specimens (with bulky, but somewhat elevated spire, long and curved canal and rather wide umbilicus) as belonging to the variety called Rapana Thomasiana by Crosse (Journal de Conch., v. 9, p. 176 and 268, pl. 9, 10). The fossil specimens are perfectly alike; they are not at all numerous in any of the tertiary deposits, and very few only occurred at Surugadai.

Lampania zonalis Lamarck. Pl. II. fig. 12.

(Hist. nat. sec. ed. vol. 9, p. 299, as Cerithium.—Sowerby, Thes. Conch. v. 2, p. 884, pl. 185, f. 264 and 265.—Adams, Genera of shells, v. 1, p. 289, pl. 30, f. 5 and 5a.—Reeve, Conch. Icon. Lampania, pl. 1, f. 5a-c.—Lischke, Japan. Meeres-Conch. v. 1, p. 73, pl. 6, f. 15 and 16, and v. 2, p. 69.).

Turreted, with the proportion of axis to diameter nearly as 3 to 1, with many plain whorls covered by some spiral ribs and by curved longitudinal ribs which make the former appear granulated, with a broad outer lip and a deep and broad notch in it, the species is easily to be recognized. From Lampania multiformis Lischke, the only other species which is important for this paper, L. zonalis differs first by the deeper notch of the lip, then by the straighter and wider canal. The other differences—stronger sculpture and tendency to graduated whorls in L. zonalis—are not constant.—I leave it undecided whether those two characters suffice to characterize L. multiformis as a species. From Takigashira-mura (v. next chapter), where the Lampaniæ are very frequent, I have among many specimens provided with a deep notch, some without it, and yet a few of the latter have comparatively strong ribs and a graduated spire. Lischke (v. 2, p. 69, pl. 5, f. 23 and 24) pronounced them a variety. Other specimens show an intermediate size of the notch; and even the canal which is comparatively the best character, shows, in one or two instances, an intermediate shape. At any rate, the specimens of Surugadai, by far less numerous than those of Takigashira, all have the characters of L. zonalis Desh. They reach the same size which is mostly seen at Takigashira, viz. 34 mm. in height and 12 in diameter.

Globulus superbus Gould.

(Otia conchol. p. 156.—Lischke, jap. Meeres-conch. v. 2, p. 83, pl. 5, f. 18-21.).

Some specimens of Surugadai corresponding—in their rather elevated spire, in their spiral furrows, in size, 15 mm. in height and 20 in diameter with 7 whorls, in the sick umbilical callus and ovate aperture—exactly to Gould's diagnosis and to Lischke's figures, I cannot but identify them. I omit to discuss the question, left also unsettled by Lischke, whether Gould's species is really a good one. The number of specimens from Yokohama and Takigashira is much larger, and moreover some of them show different characters, viz. those of Globulus monilifer Lamarck; but even there I do not find any intermediate form. I therefore think it best to separate them provisorily. At Surugadai mostly fragments are found, some of them with nice pearly lustre and with traces of colour-markings on some parts of the shell.

Cytherea meretrix Linné.

(Syst. nat. ed. 12, p. 1132.—Schrenck, nordjapan. Moll. p. 545 to 550.—Lischke, jap. Meeres-Conch. v. 1, p. 122, and v. 2, p. 108.).

Omitting the discussion about the limits of this species, most unhappily divided into a great many so-called species and varieties, and referring, like Lischke, to Schrenck's statements on this matter, I classify the Cythereæ of the tertiary beds of the environs of Tokio according to these authors. I add, however, that according to other authors the name of the frequent Japanese Cythereæ, which are identical with the fossil ones, would be C. lusoria Chemnitz (Conchyl.—Cabinet v. 9, p. 337; Lamarck, hist. nat. 2d. ed. v. 6, p. 297: Roemer, Monographie d. Mollusken-Gattung Venus p. 30, pl. 12, f. 1), of which also 'sub-varieties' have been largely established. The triangular, posteriorly elongated form, the smoothness, the typical hinge and not very thick shell, in some instances also slight colour-marks, are common to all the fossil shells. A few of them, though very small or broken, were found at Surugadai.

Cyclina sinensis (Linné) Gmelin. Pl. VI. fig. 23.

(Syst. nat. Linn. ed. 13, p. 3285.—The name was altered into chinensis by Lamarck, hist. nat. 2d. ed. vol. 6, p. 291, Reeve, Conch. Icon. Artemis, pl. 1, f. 6, Sowerby, Thes. Conch. v. 2, p. 661, Lischke, japan. Meeres-Conch. v. 1, p. 126, v. 2, p. 111, and Morse. Shell-mound of Omori, p. 27, pl. 18, f. 1.).

The height is a little greater than the length, the surface covered with fine radiating striæ crossing the lines of growth. Besides, the species is easily recognized by its crenulated inner margin and by its flat lunula. It is by far more frequent in the Tokio-Bay than it was formerly supposed to be, but it does not occur frequently in any of the tertiary deposits, and the specimens, not reaching the size of the living ones, are in every respect so much like them that there seems to be no necessity for discussing here the value of the statements of Mores concerning the smaller size and comparatively smaller length of the recent shells. The differences given by Morse—viz. 1 to 1.057 as proportion of the length to the height of shell-mound specimens, and 1 to 1.042 for the same dimensions of the recent ones—are but slight, and so the case may possibly be as in Dosinia exoleta L.

Tapes decussatus Linné.

(Syst. nat. ed. 12, p. 1135, as Venus.—Gmelin, syst. nat. L. ed. 13, p. 3294, no. 35, with varieties sub no. 57, 64 and 99, as Venus.—Lamarck, hist. nat. 2d. ed. v. 6, p. 375, as Venus.—Forbes and Hanley, brit. Moll. pl. 25, f. 1, and v. 1, p. 379.—Sowerby, Thes. Conch. v. 2, p. 693, pl. 150,

f. 115 and 116.—Jeffreys, brit. Conch. v. 2, p. 359.—Weinkauff, Conch. d. Mittelm. v. 1, p. 97.—S. Wood, Crag-Mollusca, v. 2, p. 327, Suppl. p. 145, pl. 10, f. 4.—Dunker, Mollusca Japonica p. 26.—Schrenck, nordjapon. Moll. p. 533.—Syn. Tapes Philippinarum Adams and Reeve, Zool. of the voyage of H. M. S. Samarang, Moll. p. 79, pl. 22, f. 10; Sowerby, Thes. conch. v. 2, p. 694, pl. 151, f. 146 and 147; Reeve, Conch. Icon. Tapes, pl. 11, f. 56; Lischke, japan. Meeres-Conch. v. 1, p. 115, v. 2, p. 108 and v. 3, p. 78, pl. 10, f. 4, the last representing a variety called Tapes ducalis by Roemer, Monogr. der Moll.-Gatt. Venus, v. 2, p. 82, pl. 28, f. 3.).

It seems strange, indeed, that Lischke rejects the determinations of Dunker and Schrenck, and also of Jay, based upon a scrupulous examination of hundreds of specimens, and that he tries to point out differences which do not correspond to what is really seen in the East-Asiatic specimens. They are indeed far from being always thicker, or shorter, than the European ones. The posterior dorsal margin is very often just as straight in the Japanese shells as in the European, and the differences seen in one part of the globe recur in the other. As for the sculpture, the variability of the European specimens may have even a little wider range. One of Lischke's reasons for giving T. Philippinarum as a distinct species seems to be that T. decussatus is not an arctic shell. But arbitrary as it undoubtedly is to reject the wide distribution of a species on this account, this reason is also much weakened by the occurrence of T. decussatus not only in the British seas, but also in the diluvial post-glacial beds of North-Britain.—The species is not uncommon in other Japanese localities containing tertiary beds, but only rarely met with at Surugadai. It reaches here 36 mm. in length, 25 in height and 16 in thickness.

SHINAGAWA.

The next place to be mentioned is a deep railway-cutting in the southwestern part of Tokio itself, next to the station of Shinagawa. It is very near the sea, but does not belong to the bluff-exposures mentioned in the following chapter.

The railway-cutting dissects, in its northeastern part, tertiary beds unconformably covered by lower diluvial strata. As far as the vegetation allows to see, both formations are horizontal. The unconformability, however, is obvious. The limit is undulated and slopes so rapidly, that, in the southwestern part of the same cutting, only diluvial strata, mostly formed of gravel, are exposed, and they fill up the whole cutting from the top to the very bottom. The best place for digging out shells is a few yards beyond the bridge leading over the cutting, at a short distance from the station, and 1 to 2 meters above the railway-level. This digging being kindly allowed by the authorities, I obtained here the following species already mentioned from one or both of the foregoing localities.

Neptunea arthritica Valenc.—(See Oji.)
Nassa japonica Adams.—(do. and Surugadai.)
Ringicula arctata Gould.—(See Oji.)
Columbella scripta. L.—(See Oji and Surugadai.)
Natica Lamarckiana Recluz.—(See Oji and Surugadai.)
Chemnitzia elegantissima Mont.—(See Oji.)
Odostomia planata Gould.—(do.)
Lampania zonalis Lamarck.—(See Surugadai.)
Globulus superbus Gould.—(See Surugadai.)
Dentalium entale L.—(See Oji and Surugadai.)
Panopaea generosa Gould.—(do.)
Saxicava arctica L.—(do.)
Lutraria Nuttalli Conr.—(See Oji.)
Mactra veneriformis Desh.—(See Oji and Surugadai.)
Mactra Sachalinensis Schrenck.—(do.)
Venus (Mercenaria) Stimpsoni Gould.—(See Oji.)
Saxidomus purpuratus Sow.—(do.)
Dosinia exoleta L.—(See Oji and Surugadai.)
Cardium Californiense Desh.—(do.)
Laevicardium bullatum Ad.—(do.)
Lasaea rubra Mont.—(See Oji.)
Kellia orbicularis Mont.—(do.)
Lucina borealis L.—(do.)
Pectunculus glycimeris L.—(do.)
Nucula Cobboldiæ Sow.—(do. Of this species some large specimens have been found at Shinagawa.)
Pecten laqueatus Sow.—(See Oji.)
Ostrea gigas Thunb.—(See Oji and Surugadai.)
Anomia patelliformis L.—(do.)

To these 28 species the following 8 (one of which is a brachiopod. whilst 4 are gasteropoda and 3 conchifera) are to be added.

Fusus inconstans Lischke.

(Japan. Meeres-Conch. v. 1, p. 34, pl. 2, f. 1-6, v. 2, p. 26, pl. 3, f. 1-5.)

Leaving the responsibility for the species to the author, I simply note the presence of a few specimens corresponding entirely to Lischke's description, diagnosis and figures at Shinagawa. We shall meet with the species once more in the 7th chapter.

The shell is elongated, fusiform, with a long canal, strong ribs on the elevated spire, which become much weaker on the last whorls, and spiral striæ one of which, in the middle of the upper whorls, is often placed upon an elevated carina. This character is lost in the smaller variety which occurs almost exclusively in the fossil state. It is about 80 mm. long and has a diameter of 27 mm. As for the differences from other species provided with a long canal, e. g. F. nodosoplicatus Dkr (Novit. conch. II, pl. 33, f. 3 and 4) from Japan, F. spectrum Ad. and Reeve (conch. Icon. Fusus, pl. 18, f. 68), also a Japanese form and mentioned as such by Schrenck (Nordjapan. Moll. p. 417), and F. Novae Hollandiae Reeve (l. c. f. 70) which Schrenck says is synonymous with F. Spectrum, I refer to Lischke, without entering into the above-mentioned question, for whose discussion the material provided by the tertiary layers in question is evidently not sufficient.

Neptunea (*Sipho*) *gracilis* da Costa.

(Brit. Conch. p. 124, pl. 6, f. 5.—Jeffreys, brit. Conch. v. 4, p. 335.—S. Wood, Crag Moll. I, p. 46, pl. 6, f. 10, perhaps only partly; second suppl. p. 7, pl. 2, f. 4.—Syn. Fusus islandicus Forbes and Hanley, brit. Moll. v. 3, p. 416, pl. 103, f. 1 and 3 and pl. SS, f. 2.).

The differences between Neptunea islandica, which has a bulbiform apex, N. propinqua, which has a smaller number of spiral elevated lines on the upper whorls, and N. gracilis are but slight. The latter is chiefly said to have a shorter canal and to be smaller than N. islandica Chemn.; but perhaps S. Wood may be quite right in saying (in his 2d supplement) that all these forms—together, perhaps, with Sipho tortuosus, ventricosus, Sarsii and Leckenbyi—may be only 'inconstant varieties of Sipho islandicus.'—One specimen from Shinagawa has the characters of N. gracilis.

Purpura lapillus Linné.

(Syst. nat. ed. 12, p. 1202.—Forbes and Hanley, brit. Moll. v. 3, p. 350, pl. 102, f. 1-3 and pl. LL., f. 4.—Jeffreys, brit. Conch. v. 4, p. 276.—S. Wood, Crag.-Moll. I, p. 36, pl. 4, f. 6; 2d Suppl. p. 5, pl. 1, f. 13.—Gould, Rep. on the invertebr. of Mass., 2d ed. by Binney, Moll., p. 360.).

The shell, variable as it is frequent, is but seldom found in the Japanese tertiary deposits. One fragment, belonging to the common form with strong spiral ribs and somewhat elongated in outline, has been found at Shinagawa.

Cemoria noachina Linné.

(Mantissa, p. 551, as Patella.—Lowe, zoological Journal, v. 3, 1828, p. 77, as Puncturella.—Gould, Rep. on the invert. of Mass. 2d ed. p. 276, f. 537.).

Oblong (diameters as 5 to 3), radially ribbed, with a small fissure near the apex, this small shell, about 7 mm. long, has been once found at Shinagawa. The number of the ribs is 20; concentrical striæ and mostly one very feeble rib in the middle of the interval are to be seen between them. The form and sculpture of the shell correspond exactly with the quoted figures and make it impossible to identify it with the Puget-Sound and Orange-Harbour species mentioned in Gould's Otia conchol. p. 14. The outline, especially the very different angle of divergence, and the difference of the plate distinguish this shell from Puncturella Cooperi Carpenter (Desc. of new marine shells from California, Proceedings of the Ca. Acad. of Nat. sc. v. 3.).

Limopsis aurita Brocchi. Pl. VI fig. 27.

(Conch. foss, Subapenn. p. 485, pl. 11, f. 9. as Arca.—Defrance, Dict. Scient. pl. 39, p. 224.—Goldfuss, Petrefacta German. v. 2, p. 163, pl. 126, f. 14.—Philippi, Enum. Moll. Sic. v. 1, p. 63, and v. 2, p. 45. All these authors apply the generic name of Pectunculus.—S. Wood, Crag-Moll. II, p. 70, pl. 9, f. 2 and Suppl. p. 117.—Jeffreys, brit. Conch. v. 2, p. 161.).

This species, as far as I know, has never been found living in the Pacific Ocean or in its bays, nor in the East-Indian Sea, and even the genus seems to be wanting except in the very remotest corner of this part of the ocean, in the Red Sea. The shells, not rare at Shinagawa, are easily distinguished from Pectunculus by their sharp and smooth margin. Besides, they are mostly more oblique, and their ribs are a little sharper. The cancellated surface, on which the radiating ribs prevail, is exactly the same as in the European fossil specimens, and the only difference which could be found is the number of teeth which according to Jeffreys is about a dozen. This does not correspond to the Shinagawa specimens which are partly large, reaching 17 mm. in height and 18 in length, and mostly very well preserved. They have never less than 14 teeth and often 18, or 9 on each side of the cartilage pit, and in a few instances, one—or in the posterior side even 2—may be added. But all the figures and Wood's description prove to a certainty that the normal number of teeth is indeed 18, and that a smaller number indicates either an obliteration or an imperfect stage of development. The vertical range of the species is comparatively great, as it is found in the Falun-like miocene deposits of North-Germany as well as in the Subapennine formation. It is also found in the crag and is said to occur in the glacial beds (where it may be derivative). Jeffreys and others say that it still exists near the northwestern coast of Britain.

Pecten laetus Gould.

(Otia conchol. p. 177.—Carpenter, Rep. II, p. 587; Cuming and Lischke, v. i., exclude, however, the specimens from New Zealand, mentioned by Gould l. c. p. 95 and figured in Atl. of Moll. of Wilke's Expl. pl. 42, f. 571; they unite the latter to P. Dieffenbachii Gray.—Lischke, Japan. Meeres-Conch. v. 1, p. 169, pl. 12, f. 6 and 7; vol. 2, p. 157.).

Omitting, in this case also, a critical investigation whether the species is really good or not, I identify the shells from Shinagawa with it and particularly with Lischke's figure 6 l. c. They are few in number, mostly broken. One is entire but smaller than the mentioned figure; it has 10 strong ribs with foliated projections, and the number of the intermediate ribs is mostly 3, sometimes 4 or 2. The outline is nearly circular, the length almost as great as the height. The species to be compared are P. senatorius L., but also P. hastatus Sow. (Gould's hericius), a very variable species which verges towards P. rubidus Hinds (of Alashka) as well as towards P. islandicus Muell.

Ostrea denselamellosa Lischke.

(Japan. Meeres-Conch. v. 1, p. 177, pl. 13, f. a and b, pl. 14, f. 1 and v. 3, p. 114.).

This species may be said to be still more doubtful and resembles indeed very much those forms which Wood represents (Crag. Moll. II, p. 17, pl. 1, f. 1 and pl. 2, f. 2) under the name of Ostrea princeps, or Nyst (not Sowerby) as O. undulata (Coqu. foss. de Belgique, p. 324, pl. 24, f. 7ᵃ and pl. 25, f. 7ᵇ.). Some large and good specimens were, together with many fragments, found at Shinagawa.

Waldheimia Grayi Davidson.

(Proceed. of Zool. Soc. London, 1852, p. 76; ibid. 1871, April, p. 304, pl. 31, f. 7 and 8.—Adams, Ann. Mag. Nat. Hist. 2d-series. v. 11, p. 99.).

Though only one lower valve of this species—abundantly occurring in Japan—has been found at Shinagawa, it has some importance as the only specimen of Brachiopoda of the Tokio layers. It is easily recognized by its rounded triangular ribs (about 15) and moderately transverse shape.

By the addition of the new species from Surugadai and Shinagawa the total amount becomes 76. This number is again increased by the localilies near Yokohama which are to follow in the next chapter.

CHAPTER VI.

THE TERTIARY DEPOSITS OF THE ENVIRONS OF YOKOHAMA.

KANAGAWA.

The bluffs near the station of Kanagawa (the first from Yokohama in the direction to Tokio) give a very good idea of the strata in question and of the way in which they are unconformably covered by the quaternary beds, and therefore have been represented not only in the above-quoted figure, but also in figure 2 and 3, plate I; yet they are not rich in fossils. The high, nearly vertical bluffs are almost everywhere composed of tufaceous, grayish-green rocks, mostly a little soft, and separated into thick strata. They are, of course, limited above by an undulating line, near which, in the strata themselves, sometimes a few shells appear. This is also the case in some parts of the lower strata, but the number of the specimens is always small, and they are scattered over the slope of the tufaceous and sandy clay.

The greater part of the Mollusca found are large and small specimens of *Nucula Cobboldiae* Sow., which, though mostly breaking into small fragments when taken out of the native rock, yet in a few instances were good and always helped to make out the characters of the interesting species. It was here that the specimen (Pl. VI, f. 28^a) with the smooth inferior belt of 2.6 millimeters in breadth was found. Next to be mentioned is *Mya arenaria* Linné which will be discussed with other species found at Takigashira-Mura where it is abundant. To finish the list of Conchifera, I have only to add *Ostrea gigas* Thunb., *Pecten plica* L. *Arca subcrenata* Lischke, *Dosinia exoleta* L. and *Tapes decussatus* L. Gasteropoda are not found except two *Neptuncae*, one of which is *N. gracilis* da Costa, whilst the other turns out to be the true *N. islandica* Chemn. (Conchyl.—Cabinet. v. 4, p. 150, pl. 141, f. 1312 and 1313; Jeffreys, brit. Conch. v. 4, p. 333). It differs from the foregoing, as has been said above (vide chapter 5, Shinagawa), by a more obtuse, bulbiform and upturned apex; besides, it has a more elongated spire, whilst the transverse striæ on the whorls do not differ from those af N. gracilis.

YOKOHAMA BLUFF, EASTERN PART.

From Kanagawa station the steep and high bluff-line retreats to a considerable distance and thus forms a bay between this place and Yokohama. This portion offers no remarkable localities in which fossils are to be found. The next place in which this is the case is the Yokahama Bluff in the south of the town, now covered with villas. At the point where the bluffline reaches the sea, the tertiary strata are seen to contain a shell-layer, not very much above the level of the sea and sinking nearer and nearer to it beyond the coal-stores and other industrial establishments which are here built between the strand and the bluff. For a short distance, the layer descends nearly to the strand, whilst blocks of tertiary rocks tumbled down are scattered along the shore. Here I collected, partly in these blocks, but mostly in the native shell-layer, a small number of shells, taking of course very great care not to mistake recent shells, for instance oysters which cover some of the blocks, for tertiary ones. It may be remarked, however, for this and for many other localities, that the state of preservation mostly sufficed to prevent such a mistake; for excellent as it sometimes was (exhibiting in many cases even traces of color, or nacreous lustre), yet all the tertiary shells were unequivocally fossil, resembling in every respect certain European tertiary shells, e. g. the Viennese, Antwerp and Touraine miocene shells, or those of Grignon, but above all the subapennine fossils.—The diluvial rocks—which also descend very low, just above the shell layer—do not contain any well preserved shells (indeed scarcely any shells at all), and are so different from the tertiary tufaceous clays and shell-beds that there is no difficulty in distinguishing the blocks.

LIST OF SPECIES.

Neptunea arthritica Valenciennes.—(See Oji, Shinagawa.)
Nassa japonica Adams.—(do.)
Purpura lapillus L.—(See Shinagawa.)
Lampania zonalis Lamarck.—(See Surugadai, Shinagawa.)
Panopaea generosa Gould.—(See Oji, Surugadai, Shinagawa.)
Tellina nasuta Conrad.—(See Oji, Surugadai, Shinagawa.)
Dosinia exolèta L.—(See Oji, Surugadai, Shinagawa and Kanagawa.)
Cardium Californiense Desh.—(See Oji, Surugadai, Shinagawa.)
Laevicardium bullatum Ad.—(do.)
Arca inflata Reeve.—(See Oji, Surugadai.)
Arca subcrenata Lischke.—(See Oji, Surugadai and Kanagawa.)
Pectunculus glycimeris L.—(See Oji, Shinagawa.)
Pecten laqueatus Sow.—(See Oji, Shinagawa.—Found frequently in the eastern part of the Bluff.)
Ostrea gigas Thunberg.—(See Oji, Surugadai, Shinagawa and Kanagawa.)

To these species mentioned already from Tokio two more are to be added:

Dolium luteostomum Küster.

(2d ed. of Chemnitz, Conchyl.—Cab. v. 3, Abth. 1, pt. 2, p. 66, pl. 58.—Lischke, Japan. Meeres-Conch. v. 1, p. 65 and v. 2, p. 57.—According to this author, the species is synonymous to D. japonicum Dunker, Novit. conchol. v. 2, p. 104, pl. 35 and 36; and to D. variegatum Küster, l. c. p. 74, and Schrenck, nordjapan. Moll. p. 401, *non* Lamarck.)

The bulky, deeply furrowed shell—on whose surface and mould broad ribs with narrow intervals appear, much flatter on the mould than on the shell itself—has been found rarely in the blocks and shell-layer of the Yokohama Bluff. Though mostly only moulds, the specimens, on being compared with recent Dolia, left no doubt whatever about their identity with the above-mentioned species.

Tapes euglyptus Philippi.

(Zeitschrift für Malacozool. 1847, p. 89, and Abbildungen etc. v. 3, p. 76, Venus, d. 7, f. 3.—Sowerby, Thes. Conch. v. 2, p. 680, pl. 145, f. 17. Lischke, japan. Meeres-Conch. v. 1, p. 119, and v. 3, p. 89, pl. 6, f. 8—11.)

The species which belongs to the group of Tapes papilionaceus L. shows sculpture, pallial sinus and outline doubtlessly to be identical with some specimens at Yokohama. One of them represents the variety figured by Lischke.

SOUTH WESTERN PART OF THE YOKOHAMA BLUFF.

Crossing the bluff in its western part from N. to S., we find a broad and well constructed footpath leading down to the sea-side and to the fishermen's houses placed next to the sea. This way is deeply cut into the rock and, as it crosses the line which divides the quaternary and the tertiary strata with the shell-layer, here fully developed below that line, a great many shells are dug out and spread over a part of the road, some being also visible in their native rocks on the sides of the road. Thus, though now no clear idea of the nature and position of the strata is given by this exposure, yet I was able to make here some additions to the collection of fossils. The number of species, however, which I can assign with certainty to the tertiary formation, is very small and includes nothing that has not been found also in other places. The largest number of specimens is furnished by *Mactra veneriformis* Desh., next to it by *Globulus superbus* Gould. Some specimens of *Lampania zonalis* Lamarck, a single one of *Lampania multiformis* Lischke (vide below, Takigashira Mura), on whose relation to L. zonalis I have made already some remarks when treating the latter one (from Surugadai), one specimen of *Tapes decussatus* L. and some of *Ostrea gigas* Thunb. are to be added.

TAKIGASHIRA MURA.

At the southern mouth of the canal which leads from Yokohama-harbour along the Bluff-slope and its western prolongation and at last turns to the south and reaches the sea again, the village or Mura of Takigashira is situated. Going along the canal, soon after having left the small part of the Bluff which is intersected by the canal, and on getting to the open low ground beyond, we reach a gravel-deposit which is used for engineering purposes, and is covered by unquestionably alluvial deposits. They have been described in the second chapter as mostly peaty; the lowest part of them is impure, dark-coloured sand, 0.5 meter in thickness. The pebble-stratum itself must have been exposed to the action of the sea during some part of the alluvial era, as before mentioned; but neither the admixtures of peaty and humose substance, nor the recent oysters covering some of the pebbles prove at all an alluvial origin of the entire pebble layer. For those oysters are all confined to the superficial pebbles, and the whole stratum is evidently a continuation of the layer which appears next to the limit of the tertiary deposits in the bluff slope between Takigashira Mura and Yokohama. The section seen there gives

6 metres upper diluvial loam mixed with humose soil near the surface.
9 m. grayish clay, mostly in thick strata, but sometimes alternating with thin layers of sandy soil
0.5 to 1.5 m. grayish Conglomerate.
(*line of unconformability*)
18 m. (in max.) clayish and tufaceous pale greenish-gray strata, tolerably hard.
6 m. (in the average) sandy soil, also greenish-gray.

As the conglomerate-layer very gradually slopes down to the level of the lower plain, and as it is exactly like the conglomerate-layer mentioned above, there can be no doubt about the latter belonging to the same geological horizon, viz. to the lower diluvial formation.

Below this layer and the line of unconformability, we find at Takigashira the same clayish soil which is the thickest part of the section given above. Half-way between the bluff and the place where the gravel is dug, a large quantity of shells appears, only surpassed by that of Oji. This shell-layer was afterwards found to extend from the slope of the bluff of the gravel field, though the richest development is confined to the first-mentioned place. It scarcely needs be added that only such specimens were admitted as were undoubtedly found in the strata below the gravel, and anything not found in the native soil of this part of the geological section was rigorously excluded. I found the following fossils mentioned already from other localities:

Fusus inconstans Lischke.—(See Shinagawa.)
Nassa japonica Adams.—(See Oji, Shinagawa, Yokohama.)
Nassa livescens Phil.—(See Oji. This species occurred abundantly at Takigashira.)
Rapana bezoar L.—(See Surugadai.)
Columbella scripta L.—(See Oji, Surugadai, Shinagawa.)
Ringicula arctata Gould.—(See Oji, Shinagawa. Seldom at Takigashira.)
Natica Lamarckiana Recluz.—(See Oji, Surugadai, Shinagawa.)
Odostomia planata Gould.—(See Oji, Shinagawa.)

Drillia reciproca Gould.—(See Oji.)

Lampania zonalis Lamarck.—(See Surugadai, Shinagawa, Yokohama.)

Lampania multiformis Lischke, Japan. Meeres-Conch. v. 1, p. 74, pl. 6, f. 1-10 and v. 2, p. 69, pl. 5, f. 23 and 24.—Though I expressed, when speaking about the foregoing species, some doubts about the value of the specific characters, yet the presence of all the marks given by Lischke (viz. obliqueness of the canal, and size of the notch; the flatness of the whorls, the slighter sculpture and the less elevated spire being not constant) obliges me to quote also L. multiformis from Takigashira as well as from the western part of the Yokohama-Bluff. In both places together, only a few specimens were found among a multitude of L. zonalis.

Trochus argyrostomus Gould.—(See Oji.)

Globulus superbus Gould.—(See Surugadai and eastern part of Yokohama-Bluff.)

Tornatina exilis Dunker.—(See Oji.)

Dentalium entale L.—(See Oji, Surugadai, Shinagawa.)

Solen grandis Dunker.—(See Oji, Surugadai.)

Mya arenaria Linné, Syst. nat. ed. 12, p. 1112; Forbes and Hanley, brit. Moll. v. 1, p. 168 and pl. 10, f. 4-6; Jeffreys, brit. Conch. v. 3, p. 64; Wood. Crag Moll. II, p. 279, pl. 28, f. 2; Lischke, Jap. Meeres-Conch. v. 1, p. 138; Morse, Shell-mound of Omori, p. 30, pl. 18, f. 4; syn. Mya japonica Jay, Rep. on Moll. of Perry's Exp. p. 292, pl. 1, f. 7 and 10.—The elongated form, bulbose anteriorly, obtusely pointed behind, the typical hinge etc. leave, as is universally admitted, no doubt about the identity of the recent Japanese specimens with the European, recent and fossil. There is no difference whatever between the recent Japanese shells or those of the mounds (which Morse states not to differ at all), and those found at Takigashira. The shell has not been found in Tokio, but at Kanagawa; more abundantly, than at this place or at Takigashira, it occurs in the upper tertiary sandstones of Mino (See Chapter 7.)

Mactra veneriformis Desh.—(See Oji, Surugadai, Shinagawa, western part of Bluff. At Takigashira, this species is much more numerous than the following one.)

Mactra Sachalinensis Schrenck.—(See Oji, Surugadai, Shinagawa.)

Tellina nasuta Conr.—(See Oji, Surugadai, Shinagawa, eastern part of Bluff.)

Tapes decussatus L.—(See Surugadai, western part of Bluff.)

Saxidomus purpuratus Sow.—(See Oji, Shinagawa.)

Cytherea meretrix L.—(See Surugadai. Frequently found at Takigashira.)

Dosinia exoleta L.—(See Oji, Surugadai, Shinagawa, Kanagawa, eastern part of Bluff. Rare at Takigashira.)

Cyclina sinensis Gmel.—See Surugadai.)
Kellia suborbicularis Mont.—See Oji, Shinagawa.)
Lasaea rubra Mont.—See Oji, Shinagawa.)
Lucina borealis L.—See Oji, Shinagawa.)
Arca inflata Reeve.—See Oji, Surugadai, eastern part of Bluff.
Arca subcrenata Lischke.—(See Oji, Surugadai, eastern part of Bluff.)
Pecten laetus Gould.—(See Shinagawa. Not frequent at Takigashira.)
Ostrea gigas Thunb.—(See Oji, Surugadai, Shinagawa, Kanagawa, western and eastern part of Bluff.)

Besides these 33 species found also in other places, 7 more have been collected at Takigashira which are still to be discussed:

Eburna japonica Reeve. Pl. II, f. 5

(Conch. Icon. Eburna, pl. 1. f. 3.—Sowerby, Thes. Conch. v. 3, p. 70, pl. 215, f. 11.—Lischke, Japan. Meeres-Conch. v. 1, p. 67, and vol. 2, p. 58.—Morse, Shell-Mound of Omori, p. 30, pl. 18, f. 9.)

Of this shell not at all uncommon in the Tokio-Bay and often brought to the market, only a single specimen has been found fossil at Takigashira. It is small and has the angle of divergence equal to 60°, being in this respect nearer to Morse's specimens from Omori than to the recent. It is typically developed, with the deep notch below, the ovate aperture, the smooth surface, and has even some slight traces of colour.

Purpura luteostoma Chemnitz.

(Conch. Cab. v. 11, p. 83, pl. 187, f. 1800 and 1801. Nov. ed. Küster, Buccinum, pl. 19, f. 7 and 8.—Reeve, Conch. Icon. Purpura, pl. 8, f. 35.—Lischke, Jap. Meeres-Conch. v. 1. p. 54.—Morse, Shell-mound of Omori, p. 33.)

One specimen of 37 millimeters in height and 24 in diameter, together with a few fragments, gives evidence of the existence of this species in the tertiary beds. It is typical and has broad spiral rows of big tubercles, the largest of which are placed near the upper suture; a concave spiral groove is seen next to the latter.

Chemnitzia scalaris Philippi.

(Moll. Sicil. v. 1. p. 157, pl. 9, f. 9, as Melania, afterwards as Chemnitzia.—Forbes and Hanley, brit. Moll. v. 3, p. 251, pl. 94, f. 5 and pl. FF, f. 5.—Jeffreys, brit. Conch. v. 4, p. 160.—Weinkauff, Conch. d. Mittelm., v. 2, p. 212, as Turbonilla.)

The description of Jeffreys and the figure of Forbes and Hanley perfectly agree with some specimens found at Takigashira. They are small, only 6 millimeters long and 2 broad, turreted, with shouldered whorls, which are covered with 16 strong longitudinal ribs and with many small transverse striae appearing chiefly in the intervals

This shell belongs to the warmer part of the temperate Atlantic region; but a variety, of elongated form, (see Jeffreys l. c. and Forbes and Hanley, ib. f. 1. Ch. rufescens) is more boreal, and to this variety one of the specimens may be assigned. The remark of Weinkauff, that the species has not been found fossil, seems not to be perfectly true, as Jeffreys mentions one specimen found in the Crag.

The exact resemblance of the British shells and those of Takigashira does not allow us to give them any other name in spite of the wide distance of habitat and the scarcity of the species in strata older than quaternary. Perhaps the wide Atlantic distribution, which includes the Mediterranean from Gibraltar to the Ægean Sea, and New England on the other hand, may account for the occurrence of the species on the opposite side of the palæarctic continent.

Vermetus imbricatus Dunker
(Malacozool. Bl. v. 6, p. 240. 1860, and Mollusca Japon. p. 17, pl. 2, f. 18.—Lischke, Japan. Meeres-Conch. v. 1, p. 83.—Non Sandberger, Conch. d. Mainzer Beckens, p. 112.—Syn. Serpulus Adamsii Moerch in Adams, Ann. Mag. Nat. Hist., 1864, p. 141, Schrenck, nordjap. Moll. p. 601, and Moerch, Suppl. notes to Review of Vermetidæ in Proc. Zool. Soc. 1865, p. 99.)

In regard to this species, found in congregated masses on pebbles &c. abundantly in the alluvial layers and living, but rarely and only fractured in the tertiary deposits of Takigashira, I follow the denomination adopted by Lischke.

Globulus monilifer Lamarck.
(Hist. nat. 2d ed, v. 9, p. 118, as Rotella.—Lischke, Japan. Meeres-Conch. v. 1, p. 64.)

The true Globulus monilifer, flat and covered with its sharply circumscribed, flat tubercles, has been found in small numbers together with a great many of G. superbus Gld. It has been already mentioned that I did not find any intermediate forms

Diplodonta orbella Gould.
(Proc. Boston Soc. Nat. Hist, v. 4, 1851, p. 90; Boston Journal Nat. Hist., v. 6, p. 395, pl. 15, f. 3; Otia Conch. p. 212.—Carpenter, Proc. Boston Zool. Soc., 1856, p. 202 and 218,—Lischke, Japan. Meeres-Conch., v. 2, p. 133.).

The diagnosis of Gould leaves no doubt about the identity of one entire valve—and some fragments—from Takigashira, with his Diplodonta orbella. The valve in question is 18 millimeters long, 17 high, and the total thickness of both valves would have been 15. The concentrical striæ are irregular, not very strong; the outline is more regularly rounded than in D. rotundata. The lateral tooth is much more obliterated than in D. trigonula, described above.

Arca granosa Linné.

(Syst. nat. ed. 12, p. 1112.—Reeve, Conch. Icon. Arca, pl. 3, f. 15.—Lischke, Japan. Meeres-Conch. v. 1, p. 145.—Morse, Shell-mound of Omori, p. 26.)

This shell has comparatively few—I count 18—ribs most of which, especially the anterior ones, are granulated. The outline, obliquely quadrangular and rounded at the edges, especially at the obtuse anterior, inferior edge, the hinge etc. do not present any peculiar characters. The specimens of Takigashira are very few in number, but they are partly well preserved and give unequivocal evidence of the existence of this species in the tertiary layers of central Japan. Their proportions are exactly the same as those from Nagasaki and from the Omori mound, but they are smaller (28 millim. long and 22 high). The number of ribs being like the minimum of Omori, the tertiary fossil specimens are of course much nearer akin to the latter than to the recent ones from Nagasaki.—

The total number of species from Takigashira Mura is therefore 40, and this place is superior to the other localities near Yokohama in the same way as Oji is to the other places in Tokio. Of the 53 species found altogether in the environs of Yokohama, three fourths belong to Takigashira.

The large number of species common to the layers both of Yokohama and Tokio would be sufficient to prove the identity of the formation, even if this was not geologically evident. Of 53 species 41 are identical with Tokio species.

As there are 75 species from all the places about Tokio altogether, and 2 from Kanagawa, 3 from the Bluff and 7 from Takigashira, the total number of species is 87.

CHAPTER VII.

THE TERTIARY DEPOSITS OF OTHER PARTS OF JAPAN.

Turning to the south from Yokohama, we enter the province of Sagami before we come to the place named already in the third chapter, Yokosuka, and before we arrive at the cape which forms the southwestern extremity of the Tokio-Bay. Here, thick and tolerably hard tufaceous rocks, mixed with middle- and fine-grained quartz-sand, of greenish gray color, appear on the bluff-sides, and they are often quarried. Nevertheless, the amount of organic remains exhibited by them has been trifling, and except Nucula Cobboldiæ Sow., Ostrea gigas Thunb., Dosinia exoleta L., I know nothing to mention but a few specimens of badly preserved and undeterminable gasteropoda.

A similar result is obtained in the vicinity of Hakone, where the tertiary deposits are to be seen in a great many places and are developed in the way pointed out in the introductory chapter as being typical for the mountains round the Tokio plain. Hard sandstone, conglomerate and shale alternate, and though not a complete series of strata is exposed, yet the tertiary character is evident from the similarity with the Chichibu formation. Besides, in one place, a little northeast of Otogitome, rocks have been found with a few species of shells, Dosinia exoleta, L., Cyclina sinensis Gmel., Panopæa generosa Gould, Mactra veneriformis Desh.

A much better result is obtained when we go farther to NW. and N. and enter the province of Shinshiu or Shinano, which borders Musashi—the province containing Tokio and Yokohoma—in the west, and the western end of the Musashi-province itself, the district of Chichibu.

CHICHIBU.

Several places in the valley of the Aragawa (or upper Sumidagawa), for instance Minano and a small village named Hinô between Omiya and Nigawa, or in the valley of another branch, a little farther to the north, for instance Otagawa, have furnished tertiary beds and fossils. The latter are contained in hard sandstones, or in hard sandy and marly layers between the dark shale mentioned in the introductory chapter. For miles all those rocks, which fill a wide basin amidst schistose crystalline rocks, do not show any organic remains, and only in the places mentioned above are they found in tolerably good number. Besides the specimens of fossil wood (the species of which cannot be determined) are found the following shells:

Nassa livescens Phil.
Columbella scripta L.
Dentalium entale L.
Panopaea generosa Gould.
Mya arenaria L.
Mactra veneriformis Desh.
Tapes rigidus Gould
Venus (Mercenaria) Stimpsoni Gould.
Dosinia exoleta L.
Cyclina sinensis Gmel.
Cardium Californiense Desh.
Lucina borealis L.
Leda confusa Hand.
Pecten laqueatus Sow.
Pecten plica L.
Pecten Yessoënsis Jay.
Ostrea gigas Thunberg.
Ostrea denselamellosa Lischke.
Lima squamosa Lamarck.
Terebratulina caput serpentis L

All of them, except the two last species, have been described above; they prove at the same time the very young age of the entire system of rocks, and the identity of the character of its organic remains with that of Oji, Surugadai, Shinagawa, Kanagawa, Yokohama and Takigashira. This conclusion is, of course, not altered by the two additional shells both of which live in the Japanese sea. As they are also found at Sukegawa, north of Mito, in the province Hidachi, they will be more conveniently discussed below.

SHINSHIU-PROVINCE.

The rocks found here are partly tufaceous and covered also by quaternary tufaceous rocks spread chiefly round the Asama-Yama. Among the rocks belonging to the latter formation I mention, by the way, an alunite-breccia found in the neighbourhood of the solfatara of Tadayama. The fossils to be mentioned are:

Natica Lamarckiana Reeve.
Turritella communis Risso (to be discussed below.)
Mya arenaria L.
Aulus pulchellus Dunker (also to be discussed below.)
Lutraria Nuttalli Conr.
Tellina nasuta Conr
Venus (Mercenaria) Stimpsoni Gould.

Saxidomus purpuratus Sow.
Dosinia exoleta L.
Cyclina sinensis Gmel.
Diplodonta trigonula Bronn
Lucina borealis L.
Cardium Californiense Desh
Arca inflata Reeve.
Pectunculus glycimeris L.
Nucula Cobboldiae Sow.
Pecten laqueatus Sow.
Pecten Yessoënsis Jay.
Pecten laetus Gould.

Among these 19 species, there are again only 2 which have not been mentioned in the foregoing chapters; one of them is a living Japanese species.

MINO-PROVINCE.

In this province the same system of sandstone and shale is developed as in Chichibu, and the amount of fossils is larger than in any of the districts mentioned in this chapter. As for the other animals, I refer to what I said above. The mollusca, partly well preserved, belong to the following species:

Fusus inconstans Lischke. Chiefly found at Tsukiyoshi.
Neptunea islandica Chemnitz d°.
Neptunea arthritica Valenc. Found at Tsukiyoshi and Togari.
Buccinum leucostoma Lischke (discussed below). From Togari.
Dolium luteostomum Küster. d°.
Eburna japonica Reeve. From Tsukiyoshi.
Natica Lamarckiana Recluz. From Tsukiyoshi.
Natica pyriformis Recluz. (discussed below.) d°.
Cerithiopsis rugosa Gould. d°.
Lampania zonalis Lamarck. d°.
Turritella communis Risso (discussed below.) From Tsukiyoshi and Togari, frequent.
Vermetus imbricatus Dunker. From Togari.
Globulus superbus Gould. From Tsukiyoshi.
Mya arenaria L. From Tsukiyoshi and Togari.
Solen grandis Dunker. From Togari.
Soletellina Boeddinghausii Lischke (discussed below). From Tsukiyoshi and Togari.
Mactra veneriformis Desh. From Tsukiyoshi.
Tellina nasuta Conr. From Togari.
Dosinia exoleta L. Both places, frequent and in great variety.

Cyclina sinensis Gmelin. Also from Tsukiyoshi and Togari.

Saxidomus purpuratus Sow. From Togari.

Cardium muticum Reeve. Both places.

Cardium Californiense Desh. d°.

Lucina borealis L. d°.

Diplodonta trigonula Bronn. d°.

Arca inflata Reeve. From Tsukiyoshi.

Nucula Cobboldiae Sow. Some large specimens, both from Tsukiyoshi and Togari.

Pecten plica L. Also from Tsukiyoshi and Togari.

Pecten Yessoënsis Jay. From Tsukiyoshi. Not frequent.

Ostrea gigas Thunb. From Tsukiyoshi and Togari.

Besides these shells, which entirely confirm what is said above, I cannot omit to mention the rich flora of the shale and the tufas which is nowhere found better than near Tsukiyoshi. As for the determination, I add simply that not one belongs to a species foreign to the actual Japanese flora; Acer palmatum seems to occur most frequently.

HIDACHI.

The mountains in the north of the Tokio plain, bordering the sea, are next to be mentioned. The exposures of tertiary beds are chiefly found along the coast at some distance from Mito. In a few places brown coal occurs, as it seems, under the beds described here, and it is said to extend even into the sea. The fossiliferous strata belong to a very thick system of partly hard, partly softer sandstones, sometimes a little tufaceous, but much oftener somewhat marly and intermixed with small rounded grains of rocks from the neighbouring crystalline mountains. In one instance, these tertiary rocks are enclosed within the schistose crystalline rocks and form a separate basin; this is the case upwards, or west, of Sukegawa. In all the other cases, for instance east of Sukegawa, or at Tagagori, Miyaku, they form the very last solid rocks next to the sea. They are covered by diluvial strata much in the same way as at Tokio, and it is worthy of notice that these diluvial strata are always horizontal, whilst the dip of the tertiary strata, as has been stated above, is mostly between 8° and 15°.

The fossils themselves are numerous but very often too badly preserved to be determined. It seems the less to be necessary to describe them here completely, as they will be the object of another paper prepared by Mr. Kochibe, graduate and ex-assistant of the Daigaku, now appointed at the Geological Surveying-Office of Tokio. But in order to give a correct idea of the fauna in its relation to that one which I described in the foregoing chapters, I give the following preliminary list containing the most important species.

SPECIES FOUND ALSO IN THE TOKIO PLAIN.

Fusus inconstans Lischke.
Neptunea islandica Chemnitz.
Neptunea arthritica Valenc.
Nassa livescens Phil.
Purpura lapillus L.
Eburna japonica Reeve.
Dolium luteostomum Küster.
Natica Lamarckiana Recluz.
Vermetus imbricatus Dunker.
Dentalium entale L.
Mya arenaria L.
Panopæa generosa Gould.
Solen grandis Dunker.
Mactra Sachalinensis Schrenck.
Tellina nasuta Conr.
Tapes rigidus Gould.
Tapes decussatus L.
Saxidomus purpuratus Sow.
Dosinia exoleta L.
Cyclina sinensis Gmel.
Cardium muticum Reeve.
Cardium Californiense Desh.
Lucina borealis L.
Arca inflata Reeve.
Arca subcrenata Lischke.
Pectunculus glycimeris L.
Nucula Cobboldiæ Sow.
Yoldia arctica L.
Pecten laqueatus Sow.
Pecten Yessoënsis Schrenck.
Pecten plica L.
Pecten lætus Gould (specimens from Sukegawa exactly corresponding to Lischke's fig. 6. l. c.)
Ostrea gigas Thunb.
Ostrea denselamellosa Lischke.
Anomia patelliformis L.
Waldheimia Grayi Davidson.

This list adds 7 species (Purpura lapillus L., Mactra Sachalinensis Schrenck. Tapes decussatus L., Arca subcrenata Lischke, Yoldia arctica L., Anomia patelliformis L. and Waldheimia Grayi Dav.) to the number of those which are common to the tertiary formation of the Tokio plain, and that of other districts.

SPECIES NOT FOUND IN THE TOKIO PLAIN.

Voluta megaspira Sowerby.

(Thes. Conch. v. 1, p. 208, pl. 48, f. 31 and 32.—Reeve, Conch. Icon. Voluta, pl. 20, f. 49.—Schrenck, nordjapan. Moll. p. 443.—Lischke, Jap. Meeres-Conch. v. 2, p. 167 and v. 3, p. 43.).

Many moulds and fragments occur in all the localities of Hidachi where sandstones are exposed.

Buccinum leucostoma Lischke.

(Japan. Meeres-Conch. v. 3, p. 38, pl. 1, f. 7 and 8.)

Not frequent, neither at Sukegawa, nor in the province of Mino, at Togari (vide supra). The specimens agree perfectly with the quoted figure.

Natica pyriformis Recluz.

(Proc. Zool. Soc. 1843, p. 211.—Chemnitz, Conch. Cab., 2d ed. by Kuster, Natica, p. 60, pl. 5, f. 16.—Lischke, Japan. Meeres-Conch. v. 2, p. 169, and v. 3, p. 53.).

The specimens are partly well preserved, especially those from Tsukiyoshi, province of Mino (vide supra).

Turritella communis Risso.

(Hist. nat. des pr. produits de l'Europe mérid., v. 4, p. 106, pl. 4, f. 37.—Philippi. Enum. moll. Sicil., v. 2, p. 160, and v. 1, p. 192 as T. terebra. This name is also adopted by Sowerby, Min. Conch. pl. 565, f. 3, by Jeffreys, brit. Conch. v. 4, p. 80, and by Brocchi, Turbo terebra, non L., in Conch. foss. subapenn v. 2, p. 374, pl. 6, f. 8.—Forbes and Hanley, as T. communis, in brit. Moll. v. 3, p. 173, pl. 89, f. 1-3.—S. Wood, do, Crag Moll. I, p. 74, pl. 9, f. 9.).

Numerous specimens from the province of Mino (especially Togari, but also Tsukiyoshi) enable me to identify the Japanese fossil shells which were less frequent in Hidachi, with the well known palaearctic species, whilst they differ from the living Japanese and Oriental species.

Crepidula aculeata Gmelin.

(Syst. nat. Linn. ed. 13, p. 3693.—Lamarck, hist. nat. 2d ed. v. 7, p. 642.—Reeve, Conch. Icon. Crepidula, pl. 4, f. 22 and pl. 5, f. 27.—Lischke Japan. Meeres Conch. v. 2, p. 76.)

One specimen only was found at Tagagori, Hidachi.

Haliotis gigantea Chemnitz.

(Conch. Cab. v. 10, p. 315, pl. 167, f. 1610 and 1611.—Reeve, Conch. Icon. Haliotis, pl. 6, f. 19.—Lischke, Jap. Meeres-Conch. v. 1, p. 101, and v. 2, p. 91.—Syn. H. Kamtschatkana Jonas. Reeve l. c. pl. 3, f. 8.)

A few but partly excellently preserved specimens were found at Sukegawa, Hidachi.

Patella amussitata Reeve.

(Conch. Icon. Patella, pl. 33, f. 83.—Schrenck, nordjapan. Moll. pl. 14, f. 4 and 5.—Lischke, Jap. Meeres-Conch. v. 1, p. 109 and v. 2, p. 100, pl. 5, f. 7-11.)

The species, rather variable, has been found in tolerably large specimens, some of which were well preserved, in several places along the coast of Hidachi.

Aulus pulchellus Dunker.

(Novit. Conch. II, p. 20, pl. 6, f. 4 and 5.—Lischke, Jap. Meeres-Conch. v. 1, p. 124.—Syn. Aulus costatus junior Schrenck, nordjapan. Moll. p. 590, Middendorf, Reise &c. v. 2. first portion, p. 269; Aulus costatus Say, from the Atlantic coast of America.).

Without entering upon the question of the identity of these two species, answered in an opposite sense by Schrenck and Lischke, I mention the specimens from Hidachi and Shinshiu, tolerably numerous and belonging undoubtedly to the same species as those of Dunker.

Soletellina Boeddinghausii Lischke.

(Japan. Meeres-Conch, v. 2, p. 118, pl. 9, f. 9.).

In all the localities of the provinces of Hidachi and Mino moulds of this species are found; the shells themselves were less frequent.

Lima squamosa Lamarck.

(Hist. nat. 2d ed. v. 7, p. 113.—Lischke, Japan. Meeres-Conch. v. 1, p. 162.—Syn. Ostrea lima Linné, Syst. nat. ed. 12, p. 1147 and Sowerby, Thes. Conch. v. 1, p. 84, pl. 21, f. 1.)

This nearly world-wide species about which Lischke's discussion may be referred to, has been chiefly found in the Brachiopoda-beds near Sukegawa which will be mentioned below; but it occurs also in other places of Hidachi and in the district of Chichibu.

Mytilus edulis Linné.

(Syst. nat. ed. 12, p. 1157.—Forbes and Hanley, brit. Moll. v. 2, p. 170, pl. 48, f. 1, 3 and 4.—Reeve, Conch. Icon. Mytilus, pl. 8, f. 33.—Jeffreys, brit. Conch. v. 2, p. 104.—Weinkauff, Conch. d. Mittelm. v. 1, p. 224.—Philippi, En. moll. Sicil. v. 1, p. 73 and v. 2, p. 53.—S. Wood, Crag Moll. II, p. 52, pl. 8, f. 9 a-c, and p. 55, pl. 8, f. 10 as M. hesperianus.)

Omitting to mention all the varieties, I only add that the recent Mytili of Japan—not all of them like Mytilus Dunkeri Reeve (Conch. Icon. Mytilus, pl. 5, f. 17; Lischke, Japan. Meeres-Conch. v. 1, p. 153, pl. 10, f. 7 and 8) or like the other forms described by Lischke and other authors—must be, mostly at least, united with the true M. edulis L., whose variability is indeed almost universally acknowledged. The same is the case with the shells and moulds from the Hidachi sandstones, whose number, however, is but small.

Modiola flabellata Gould.
(Otia conchol. p. 93. Atlas of Mollusca of Wilke's Exped. pl. 40, f. 561.)

This Oregon species is doubtlessly represented by a few of the moulds of the Sukegawa sandstones.

Terebratulina caput-serpentis L.
(Syst. nat. 12th ed. p. 1153, as Anomia; excl. syn.— Ib. p. 1151, as Anomia retusa.—Lamarck, hist. nat. &c. 2d ed. v. 7, p. 332, as Terebratula caput-serpentis.—Forbes and Hanley, brit. Moll. v. 1, p. 353, pl. 56, f. 1—4, also as Terebratula. Reeve.—Conch. Icon. pl. 4, f. 19; also in Monogr. of recent Brachiopoda.—Jeffreys, brit. Conch; v. 6, p. 69, as Terebratula — Sowerby, Min. Conchol. v. 6, p. 69, as Terebratula striatula.—Philippi, Enum. Moll. Sicil. v. 1, p. 96 and v. 2, p. 66; do.—Weinkauff, Conch. d. Mittel-meeres v. 1, p. 285.—Adams, Ann. Mag. Nat. Hist. 3d series, v. 11, p. 68, with varieties T. japonica and T. Cumingii.—Davidson, Proc. Zool. Soc. 1871, p. 303, pl. 30, f. 7, 8 and 9.).

Though the outline and size—as this is often the case with Brachiopoda and especially with Terebratulinae—are somewhat different from the typical specimens, those of Hidachi reaching 34 millimeters in height and 32 in length, yet the characters, for instance the sculpture, agree so perfectly that they cannot be referred to different species. Even as a variety this fossil form cannot be separated from the recent Japanese specimens, since the latter, from Hakodate, have the same—and in some instances a little larger—size and exactly the same proportions.—The specimen mentioned above from Chichibu is much smaller.

Rhynchonella psittacea Gmelin.
(Syst. nat. Linn. 13th ed., 3318. as Anomia.—Lamarck, Hist. nat. etc. v. 6, 1st div., p. 248.—Davidson, Proc. Zool. Soc. London, 1871, p. 309, pl. 31, f. 12.—Adams, Ann. Mag. Nat. Hist. 3d series, v. 11, p. 100, established a variety as Rh. Woodwardi.)

Specimens corresponding perfectly to the description and figure of Davidson, but reaching 30 millim. in height add 34 in length—in one case even 36—, have been found exclusively in the isolated basin west of Sukegawa. They were associated with the foregoing species, which occurred also abundantly and almost exclusively at this place.

The sandstone and marly conglomerate filling the valley encircled by crystalline rocks, and overlying unconformably mica-schist, calcareous mica-schist, cipolline and other crystalline limestones, might be indeed called the 'Sukegawa

Brachiopoda-beds' from the frequency of those two species. This is the more striking as other fossils are comparatively rare and belong only to 5 species, viz. Pecten laetus Gould, Lima squamosa Lamarck, Ostrea gigas Thunberg, Ostrea denselamellosa Lischke and Anomia patelliformis Linné. The identity of the formation, however, is evidently proved by the similarity of the rocks to those near the coast, and by the species of shells; for they are all recent Japanese and with one exception found also at Oji, Takigashira &c.

Among the other fossils some sea-urchins might be mentioned, and some fragments of fossilized wood partly reaching huge dimensions. Unfortunately, they are all too badly preserved to be of any importance.

In concluding the remarks about Hidachi, I have to mention a locality on the road from Tokio to Mito, near the Tonegawa and next to the village of Kogone. This locality is included within the compass of the Tokio environs, but its formations are intermediate between those of Tokio and those of Hidachi. They consist of a tufaceous sandstone, very much like that of Sukegawa, only a little softer. It is covered by diluvial strata, mostly also sandy. From the tertiary strata Mactra veneriformis Desh., Cytherea meretrix L., Arca inflata Reeve were brought to me.

LOCALITIES ON THE ISLAND OF KIUSIU.

The thick and varied system of sandstones, tufas, conglomerate and shale which is seen along the coast on both sides of the Tokio plain as well as in the hills surrounding it, is, of course, not limited to central Japan. I am fully convinced that it will be discovered almost along the whole eastern and southern shore, and probably it does not end there. To the south and west, this may be said to a certainty; for in the island of Kiusiu several places are already known and have been explored which doubtlessly contain the same formation.

At Amakusa, tufaceous rocks, somewhat fine-drained, contain a great many moulds of bivalves—Tellina nasuta Conr., Tapes rigidus Gould, Pecten plica L., Mactra Sachalinensis Schrenck, Diplodonta trigonula Desh., Arca granosa L., Cardium Californiense Desh., Saxidomus purpuratus Sow.—and moulds and shells of Turritella communis Risso.

In the ken of Kagoshima the amount of tertiary fossils is still larger, though we cannot include in this formation *all* the layers of plants frequently found in this part and in other districts of the island; for some of them are quaternary and belong to very modern fresh-water deposits. The fossil shells are Nassa livescens Phil., Natica pyriformis Recluz, Lampania zonalis Lamarck, Tellina nasuta Conr., Mactra veneriformis Desh., Cytherea meretrix L., Cardium Californiense Desh., all the three Arcæ described above and both species of oysters.

Near Bungo, on the northeastern corner of the island, blocks with Dosinia exoleta L., Mactra veneriformis Desh., Saxidomus purpuratus Sow. and Cardium Californiense Desh. are found.

NORTHERN LOCALITIES.

Similar rocks have been brought from Rikusen, a little NE. of Sendai, containing Pecten plica L., Dosinia exoleta L., Panopaea generosa Gould and Saxicava arctica L.: whilst at Hakodate not only similar rocks have been seen, but also smaller and well preserved fossil shells, much like those of Oji or Shinagawa, have been dredged. The most important of them is Limopsis aurita Brocchi, of which a few specimens, doubtlessly in a fossil state, are in the zoological collections of the Daigaku.

Another locality is situated between Sendai and Hidachi, in the province of Yuwashirô. The pliocene rocks, greenish tufaceous sandstones, have been found in tunnelling through a range of low hills south of Yuwashirô-su (Manaita-sawa, Asakagori). Here Cardium muticum Reeve, large and typical, Lucina borealis L., Mactra veneriformis Desh., Tellina nasuta Conr., Pecten laqueatus Sow and stems and leaves of plants (Cryptomeria japonica, and a Carpinus) are found.—

The tertiary beds beyond the Tokio plain, in their totality, have furnished 60 species, 46 of which are also contained in the Tokio-and Yokohama-layers, and only 14 (about 23 percent) are new; but these are all recent and with two exceptions Japanese. Only one of them does not occur in the Pacific.

The different localities do not differ much in their proportion, Chichibu having 20 species with 2 new ones, Shinshiu 19 with two new ones, Mino 31 with 4 new species; Hidachi with 50 species has, however, 14 new ones, whilst the other localities in which only a few species are found, have no new ones. The largest number of new species, therefore, belongs to Hidachi, where the 'face' of the formation is also modified. The modification, however, and the number of new forms is not very great, and the character of the fauna, in its totality, is not altered.

CHAPTER VIII.

SUMMARY.

It would be perfectly clear, I believe, even without the assistance of the facts contained in the foregoing chapter, that the shell-layers which are the subject of the 4th, 5th, and 6th chapter, though they are very young, yet belong to the tertiary formation. For the Tokio-and Yokohama-exposures exhibit an *unconformability* which separates the bulk of the diluvial formation (divided in itself by another line of unconformability) from an underlying formation, and the latter contains a molluscous fauna comprising living species, many of which are not now found in the neighbourhood of Japan nor even in the Pacific. Besides, in some localities within the Tokio plain, the strata below the same line of unconformability have a dip of 5 to 6 degrees, whilst the diluvial strata are horizontal.

To illustrate the character of the fauna, I resume that in the upper tertiary deposits of the environs of Tokio and Yokohama 87 species have been determined. Two of them, Dentalium octogonum Lamarck and D. entale L., belong to the Solenoconchæ; one of them is recent and Japanese, the other exclusively found in the Atlantic. A third species belongs to the Brachiopoda and is recent and Japanese. The rest are 41 Gasteropoda and 43 Conchifera. Among the former, 9 are neither Japanese nor Chinese; if we include the species described by Gould from Hongkong or its vicinity, e. g. Cerithiopsis rugosa, Monoptygma puncticulata, the two Odostomiae, as indigenous in the neighbouring seas, the number of the indigenous species is 52. The rest includes only one boreal univalve of the Pacific Ocean, Trichotropis coronata Gld, not found hitherto further south than the strait of Semiavine. The remaining species are Atlantic, and though none of them are really extinct, they are geographically separated by a wide interval from the living Japanese fauna. Most of them are very often found in a fossil state, just as a certain number of the other 32 gasteropoda, especially those which at present are common to the Atlantic and Pacific Ocean, e. g. Columbella scripta L., Purpura lapillus L., Chemnitzia elegantissima Mont.—Among the 43 Conchifera there are only 7 which are not living in the Japanese sea, and among them we find 2 boreal Pacific species, Panopaea generosa Gould and Lyonsia flabellata Gould, the former going southward to Oregon but not to the East-Asiatic temperate coasts. But the other 5 are important species, viz. Kellia suborbicularis Mont., Lucina borealis L., Diplodonta trigonula Desh., Yoldia arctica L., an important arctic form, and above all Limopsis aurita Brocchi, which belongs to a *genus* whose next locality is the Red Sea. Limopsis aurita itself was, until very lately, said to be extinct. Deep-sea dredgings may indeed, as has been the case with this species, reduce the number of really extinct tertiary forms; but this is a fact which is applicable to all the younger tertiary deposits. It proves indeed that an extinct fauna must be considered as such even if it does not contain any other but living species, whenever a larger part of these species does not belong to the recent fauna of the same zoogeographical province or region.

Of course we find also in the class of Conchifera many species which are Atlantic as well as Pacific. Two of the bivalves, Saxicava arctica L. and Mya arenaria L., are circumpolar; one, Lasaea rubra Mont., is cosmopolitan. A great many are also fossil, especially of those common to both the western and eastern ocean, and I think it will not appear a very paradoxical result that—aided by a rich supply of specimens—I added to their number Dosinia exoleta L. and Nucula Cobboldiæ Sow. and replaced to it Tapes decussatus L., known from the Japanese coast as Dosinia japonica and Troscheli, as Nucula mirabilis and insignis, and as Tapes Philippinarum. In this respect, I am indeed fully convinced that in Japan exactly the reverse will take place of what Lischke says to be commonly the case, viz. that in every fauna which is imperfectly known a further revision will probably reduce the number of the *foreign* forms, or of those species which are said to be identical with forms of another part of the globe. Lischke himself has shown by too many examples that the marine molluscous fauna of Japan is—just as the fauna of other classes of animals—palæarctic. Perhaps it would appear still more so if we knew the real distribution and geographical range of some genera and species now mostly confined to southern latitudes, as for instance Myadora. At all events, we have in the fauna of Oji, Tokio, Kanagawa, Yokohama, Takigashira elements which do not agree with the actual Japanese fauna, and the number and importance of these elements is so great as to remove all possibility of their ever being effaced by discoveries of recent Japanese shells. I need scarcely add that some of the species which are extinct on the East-Asiatic coast, occur very frequently in the tertiary layers, e. g. Lucina borealis, Diplodonta trigonula, Limopsis aurita.

In these as well as in many other respects the Japanese shell-layers discussed above have the greatest resemblance to the *Crag*, and next to it with the younger Subappenine deposits, whilst the rocks resemble very closely the European *Faluns*, a formation, by the way, not at all limited to the western coast of France. Glacial deposits have no more affinity with the Oji deposits than with the English Crag itself, and it would be very easy to match the 'arctic' species undoubtedly contained in these deposits by others—Cyclina sinensis, Arca granosa, Monoptygma, Myadora, or even Diplodonta trigonula—which point more to the south. And thus we should at last be obliged to recur to the explanations given above on this subject.—

If, however, all these reasons should not seem to give sufficient evidence of these views, the localities described in the seventh chapter will do so in a perfectly satisfactory manner.

All these strata of shale, sandstone, hard and loose conglomerate have, as is repeatedly stated, an enormous thickness and yet a perfectly uniform fauna. And this fauna is eminently the same as at Oji, Takigashira etc.

The results given at the end of the 7th chapter show that in the localities first mentioned, Chichibu, Shinano, Mino, altogether 44 species have been found which belong to the fauna of Oji, Takigashira &c., and that there are only 7 new species; whilst in Hidachi 36 species from Oji, Takigashira etc. and 14 new ones have been found. But Hidachi, on the other hand, is closely connected with the other localities by the identity of 30 of the former and 7 of the latter species, and thus, only 7 species remain peculiar to Hidachi. These 7 species are all of them living in the Japanese sea, and it is a remarkable fact that the separate basin near Sukegawa, richest comparatively in such species as do not belong to the fauna of Oji and Takigashira (3 among 7), has not one species which is not found living near Japan. All the other localities, and the more distant places, have proportionally very few species (if any) not belonging to the Tokio fossil fauna; and all of them together with Hidachi have only *one* species which is neither found in the fossil fauna of Oji etc., nor among the living shells of Japan, viz. Turritella communis Risso. As the proportion of fossil Tokio shells belonging to the living Japanese marine fauna to those which are extinct in Japan is 69 to 18, the latter being 21 percent, the presence of one further species of the latter description with 13 new species living in the neighbourhood would rather serve to prove a younger age of the sandstone, conglomerate, marl and shale. As this cannot be admitted, the Tokio layers being undoubtedly one of the higher, if not of the very highest parts of the younger tertiary formation of Japan, we are forced to regard both layers as most intimately united.

A further division of the entire system cannot be made, at present, palæontologically; we must confine ourselves to separating it into upper and lower strata simply according to their relative position.

There can be no doubt about its very young age, and the *Pliocene Era*, or the Crag-division of the tertiary formation, is the only one to which we can assign it. If the question should arise whether we should assume that it belongs to the miocene formation, this is answered in the negative by the absence of a somewhat larger number of extinct shells, by the scarcity of typical miocene species (though there are some present, for instance Columbella scripta, Chemnitzia elegantissima, Eulima subulata, Dentalium entale, Lucina borealis, Diplodonta trigonula, Pectunculus glycimeris, to which perhaps some other, for instance Panopaea generosa and the Tornatina might be added), by the close resemblance to the Crag and by an approach which those layers make towards the diluvial deposits.

With these, however, they cannot be identified for the reasons given at the beginning of this chapter—character of fauna, high percentage of species foreign to the present marine fauna of Japan, line of unconformability between them and doubtless lower diluvial strata—, and besides for those reasons which result from the identity of the Tokio pliocene strata and the system of sandstone, shale &c. amounting at least to some hundred meters in thickness. This very thickness, clearly shown by the Chichibu-layers as well as by those of Hidachi and other provinces, and still more the *high angle of dipping* often observed, forbids the inclusion of these strata within the compass of the quaternary formation. Now, not being able to claim a quaternary age for these large systems of rocks, we cannot do so for the Oji rocks and their parallels in the Tokio plain.

The solution of this problem is of the highest importance for Japanese geology. The strata in question occur almost everywhere; at least in almost all the provinces and districts which thus far have been explored. We find them, with or without other sedimentary or volcanic or crystalline rocks, not only along the coast, but often far into the interior. Their geological age ascertained, we have a fixed point from which we may advance, and without which we should scarcely have a sufficient basis for observation anywhere. This is true as well in regard to the underlying strata, tertiary, for instance brown coal, mesozoïc, palæzoïc or azoïc, as to all the eruptive formations and to the overlying quaternary strata which give the surface-formation of wide districts. The largest of these is the plain of *Tokio,* whose geology could never be fully understood without a strict determination of the fossiliferous deeper layers of its environs.—

This point being settled, I may add a few remarks about the geological changes which, since the origin of those oldest deposits of the Tokio plain, are to be observed within this district.

The character of the fauna may be dismissed after all that has been said about it here and in the introductory chapter. I repeat only that the marine fauna also gives evidence to a highly satisfactory degree of its *palaearctic* character. The molluscous fauna of Japan is much more closely connected with the European fauna than we should have ever expected without recurring to the faunæ of past ages. This connection is much too intimate to be accounted for by the small number of 'circumpolar' species contained in the Japanese fauna; but it is well explained by the close affinity which the pliocene fauna reveals with the European. It has, therefore, a far greater importance than it would have if it was an isolated faunula and not—as it is—a part of a very large fauna which, in certain respects, has been better preserved in Japan than in the other parts of the palæarctic region. I need but call the reader's attention to the important fact that the pliocene Nucula Cobboldiæ actually exists in the ocean encircling Japan.

As the question about the temperature has also been settled in the first chapter, I may proceed to the last object of these pages, to the question concerning the changes of the level of the sea.

Of course there can be no doubt whatever about the fact that since the deposition of the pliocene strata the land has been slowly elevated above the level of the sea. This movement of the entire mass of land forming the Japanese archipelago, has, to a certainty, not gone on quite regularly and must have been at times interrupted; but, on the whole, it has continued from the last period of the tertiary age to the present day. The interval between the pliocene layers and the diluvial strata, causing that line of unconformability often mentioned, may have been filled up by an extent of land greater than at present; and the occurrence of two of the palæarctic species of elephants seems to point to the same fact. But soon after the beginning of the diluvial era another submersion must have taken place to which another elevation succeeded. And this elevation has doubtlessly continued up to the present time.

This seems to be proved, if not with certainty, yet with some probability, by the Omori shell-mound. A mound of such a size is likely to have been heaped next to the sea; and I think the discoverer of this mound is perfectly right in laying some stress upon this matter.

On the other hand, it seems scarcely possible to make any calculations concerning the *amount* of the increase of land, or the rapidity with which the soil of Japan is elevated above the level of the sea. Much greater precautions must be taken, in this respect, than has generally been the case. If we should, for instance, compare the result of the soundings in the bay of Tokio made at different periods, we might perhaps, at a short distance from the shore, perceive a comparatively great diminution of the depth of the bay, and yet the real amount of the elevation might be trifling. For a large mass of detritus is daily brought into the sea by the rivers, by the sea itself, by men; and this mass is distributed mostly along the coast. We are not allowed, therefore, to draw any conclusions concerning a rising of the entire mass of land from soundings made next to the shore, especially in the harbours, and above all in the harbour of Tokio. Just as untenable are the results derived from the increase of land in the precincts of the town itself. Swamps extending along the coast may have been made artificially accessible to men, and therefore they are said now to be land, whilst on the old maps and in the old traditions they are said to belong to the sea. To this Increase of land, which must be declared to be strictly local, the stagnations produced by weirs—above which always a large bulk of detritus is retained and accumulated—add of course a great deal, and this has been evidently the case in some parts of Tokio.

I am far, therefore, from sharing the views contained on this subject in Dr. Naumann's paper on the Tokio plain. Especially do I think that his estimate of years is incorrect. The very short time assigned for the formation of the plain of Tokio, viz. 45000 years—given, it is true, as a minimum—seems to be quite inconsistent with the amount of time which we really must assume for our geological periods.

Still less tenable, of course, is the view that within historical time the Tokio plain has ever been covered by the sea. This is not only the case with the higher parts of the plain formed by diluvial strata, but also for the lower or alluvial parts. Man may have previously existed (as he has been proved to be contemporaneous not only with the cave-bear and the mammoth, but also with Elephas antiquus in Europe); but he can only have existed as a prehistoric race similar to the man of Enghis and of Neanderthal.

The rising of the land seems to be independent of the volcanic phænomena. We find indeed such elevations in any part of the world, with or without volcanic action, and the question is a very complicated one, whether—or how far—this action may be the cause of the rising of land. On the other hand, this rising seems to have an influence on the volcanic phænomena, namely, that it tends to mitigate them and causes them to withdraw from certain parts. The volcanoes seem to be dependent upon the presence of water, and thus a diminution and retreat of volcanic action in Japan is perfectly accounted for.

It has been said above, that we are not entitled to assume a heightened degree of volcanism during the quaternary age; and when we consider the large layers of quaternary conglomerates, which even in volcanic districts cover tufaceous rocks, without being tufaceous themselves, this conclusion cannot but be confirmed. The level which, in such instances, is reached by quaternary layers, is sometimes very high. In the district of Hakone it is decidedly above 700 meters. But we do not know whether these strata are not fresh-water deposits kept up in a high level much like the present lake of Hakone.

The volcanic action, not very intense, after all, at present in Japan, seems —as above stated—to have had its maximum about the same period at which the youngest tertiary deposits were made, as is proved indeed by the large amount of tufas found among these rocks, and the more so, the nearer we are to the volcanic centres pointed out in the first chapter.—

With these remarks founded upon minute investigation I conclude the sketch of the 'Geology of Tokio,' by which I hope to give some impulse to, and some basis for, further observations and studies.

EXPLANATION OF PLATES.

PLATE I. Geological Sections.

Fig. 1. Section of the diluvial and tertiary strata of the steep Bluff NW. of Kanagawa-Station. Vide p. 21.

Fig. 2 and 3. Sections of the same strata, from the Bluff between the railway and the shore, next to Kanagawa-Station. Vide p. 26.

Fig. 4. Section of the diluvial and tertiary strata near the corn-mill at Oji, N. of Tokio. Vide p. 26.

PLATE II. Fossils from the pliocene deposits.

Gasteropoda.

Fig. 1. Neptunea arthritica Valenciennes. From Oji. V. p. 28.
— 2. Rapana bezoar L. From Surugadai. V. p. 51.
— 3. Nassa japonica Lischke. From Oji. V. p. 29.
— 4. Nassa livescens Philippi. Do. V. p. 29.
— 5. Eburna japonica Reeve. From Takigashira. V. p. 64.
— 6. Columbella scripta L. From Oji. V. p. 29.
— 7. Odostomia planata Gould. Do. V. p. 32.
— 8. Cerithiopsis rugosa Gould. Do. V. p. 33.
— 9. Prillia reciproca Gould. Do. V. p. 33.
— 10. Mangelia striolata Sow. Do. F. p. 33.
— 11. Terebra bipartita Gould. Do. V. p. 34.
— 12. Lampania zonalis Lamarck. Specimen from Takigashira. V. p. 52.

PLATE III. Fossils from the pliocene deposits.

Conchifera.

— 13. Solen grandis Dunker. From Oji. V. p. 36.
— 14. Panopaea generosa Gould. Do. V. p. 36.
— 15. Mya arenaria L. From Takigashira. V. p. 59 and 63.

PLATE IV. Do. continued.

— 16. Lutraria Nuttalli Conr. From Oji. V. 38.
— 17. Mactra veneriformis Desh. Specimen from Takigashira. V. p. 38.
— 18. Tellina nasuta Conr. From Oji. V. p. 39.

PLATE V. Do. continued.

— 19. Tapes rigidus Gould. From Oji. V. p. 39.
— 20. Saxidomus purpuratus Sow. Do. V. p. 40.
— 21. Venus (Mercenaria) Stimpsoni Gould. Do. V. p. 40.

PLATE VI. Do. CONTINUED.

— 22. Dosinia exoleta L. (var.) From Oji. V. p. 41.

— 23. Cyclina sinensis Gmel. Specimen from Takigashira. V. p. 53.

— 24. Lucina borealis L. From Oji. V. p. 44.

— 25. Diplodonta trigonula Bronn. Do. V. p. 44.

— 26. Pectunculus glycimeris L. Do. V. 45.

— 27. Limopsis aurita Brocchi. From Shinagawa, V. p. 57.

— 28. Nucula Cobboldiæ Sow. From Oji. V. p. 46.

— 28ᵃ The same, specimens from Kanagawa. V. p. 46, and p. 59.

— 29. Yoldia arctica Broderip. From Oji. V. p. 47.

PLATE VII. Do. CONTINUED.

— 30. Pecten plica L. From Oji. V. p. 48.

— 31. Pecten laqueatus Sow. Do. V. p. 48.

— 32. Anomia patelliformis L. Specimens from Shinagawa. V. p. 49.

PLATE VIII. SKETCH MAP OF THE ENVIRONS OF TOKIO. Scale 1 : 1000000.

ADDENDA AND ERRATA.

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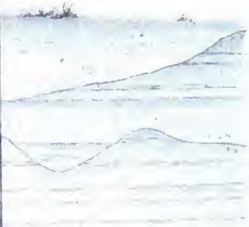

f Kanagawa Bluff
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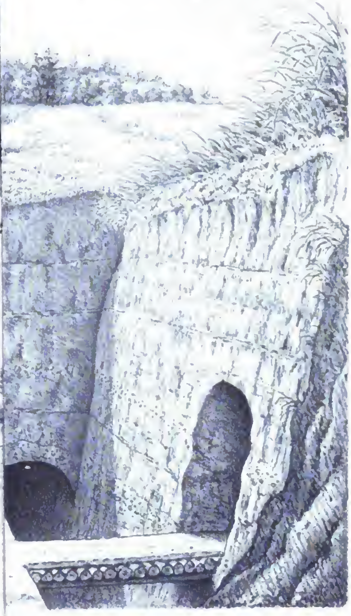

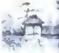

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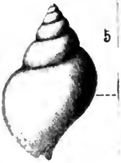
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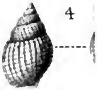
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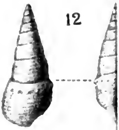
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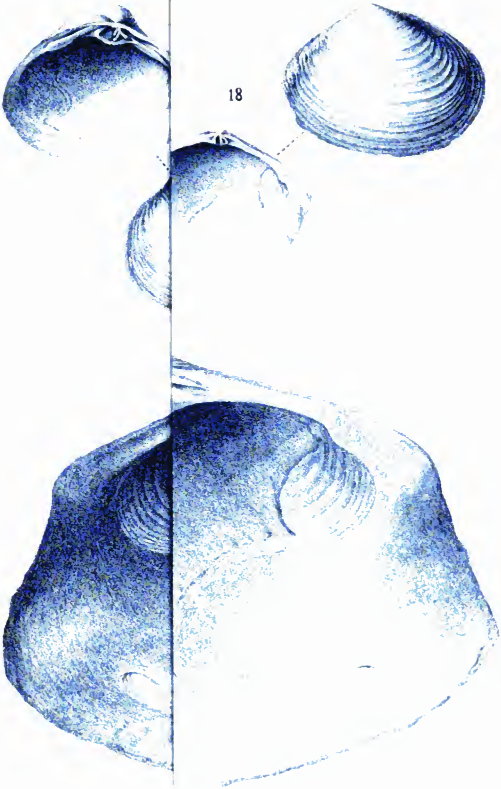
1. Neptunea
4. Nassa lives
7. Odostomia
10. Mangelia

13.

Pl.IV.



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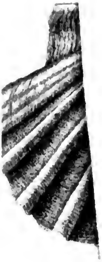
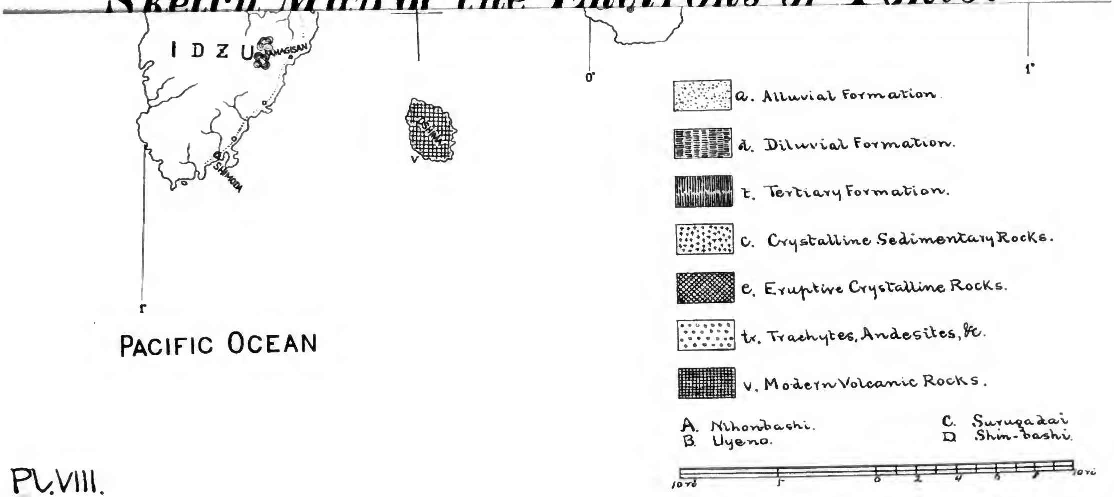


3

Sketch Map of the Environs of Tokio.



PL. VIII.

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